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RECENT DEVELOPMENTS IN PHOTOELECTRICITY[1]

By Professor C. E. MENDENHALL

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THE general quantum theory may be said to have been born of a black body and sired by the photoelectric effect. Consequently, since we are all, willy-nilly, quantists, every one has at least a genealogical interest in photoelectricity. For some, this interest is enhanced by a certain fascination of the phenomenon itself, and just at present the relation of experiment to statistical and wave-mechanical theory is attracting particular attention. While it is my purpose to discuss mainly recent aspects of the subject, though with no attempt at completeness, it will be useful for the sake of clarity to restate very briefly certain of the earlier generalizations, in order that the later material may be placed in proper relation to them.

The term photoelectricity covers what are, from the standpoint of technique at least, two distinct fields, the "external" and "internal" effects, the latter being sometimes more descriptively called "photo-conductivity," and it is with the former only that we shall be concerned. Furthermore, the "external effect" itself involves two sets of phenomena, which are experimentally and theoretically quite distinct, according as the matter from which electrons are being removed is in the one case a vapor or in the other case a solid or liquid.

The case of a vapor is obviously the simplest, but it has been the last to be developed because of experimental difficulties. The Bohr theory led one to expect that if the energy of the light quantum equalled or exceeded the ionization energy of the atom, or molecule, ionization would result, and experiments of Williamson, Lawrence and others have verified this and given values of the ionization potential consistent with other determinations. On account of the difficulty of working with sufficiently short wave-lengths,

[1] Address of the retiring vice-president of Section B—Physics, American Association for the Advancement of Science, Cleveland, December 31, 1930.

photoelectric measurements of ionizing potentials have been carried out only with the vapors of the alkali metals. However, a repetition of some early work of Steubing's carried out with very considerable improvements by Rouse and Giddings has led to a considerable study of what might be called secondary phenomena, namely, ionization in what were thought to be monatomic vapors by light whose quantum value is *less* than the energy necessary for ionization —in some cases not half the necessary amount. In the case of mercury and cadmium the atomic absorption of the resonance line, resulting in excited atoms, is the primary action, and *two* such excited atoms are necessary for ionization. In the case of the alkali metal vapors, as studied by Foote, Lawrence and Edlefson, and Mohler and his coworkers, not only does absorption in the atomic series lines produce ionization, but there is a continuous background of absorption of wave-lengths longer than the ionization limit, which also results in ionization. The most probable explanation of all such cases involves a suggestion of Franck's that the ions observed are molecular, though no direct confirmation of the presence of such ions has yet been made by measurements of $\frac{e}{m}$. In the case of mercury and cadmium the molecules are probably formed by the combination of two excited atoms. In the case of caesium, Mohler and Boeckner conclude that neutral molecules are initially present either in the normal or in some vibrational state—the range of vibrational states present accounting for the range of wave-lengths longer than that corresponding to the ionization of the normal molecule, which will actually produce ionization. This type of photoelectric effect thus leads one at once into the theory of molecular structure and of impacts between molecules and atoms. In the hands of Mohler and his coworkers it has proved a very sensitive means for studying the distances involved in such collisions as dependent on the excited states of the atoms, as well as the mean life of these states.

Turning now to the photoelectric discharge from solids and liquids, the problem is of course entirely different and molecular and atomic theory has not yet come to play a part in it, though there are some very puzzling empirical correlations between photoelectric quantities and atomic constants. The earlier generalizations can best be summarized by Einstein's two famous equations, which not only correlated the facts so beautifully, but gave to the young quantum theory an aspect of much greater physical reality. These equations are:

$$U = 1/2\, m \cdot v^2_{max} = h\nu - e\varphi = h(\nu - \nu_o)$$

$$N = \frac{Q}{h\nu} = \frac{Q\lambda}{hc}$$

where U is the *maximum* energy of the electrons after emission due to light of frequency, ν, ν_o is the low frequency limit, N is the number of electrons emitted by the *absorbed* light energy Q, λ is the wave-length corresponding to ν v_{max} is the maximum electron velocity, and h is the Planck constant of action. The process according to these equations is very simple. Each quantum gives up *all* its energy to a single electron (thereby distinguishing the photoelectric from the Compton and Raman effects later discovered) and if that energy is greater than $e\varphi$, the work necessary to get the electron through the surface, the electron is emitted.

In determining the maximum velocity of emission by direct experiment it is usual to apply an electron-retarding field between the illuminated metal and a surrounding receiver. If the potential difference between the metal and receiver is adjusted until the fastest photo-electrons are just prevented from reaching the receiver, this potential difference is called the stopping potential, V_s, and we have the relation

$$1/2\, mv^2_{max} = (V_s + V_c)e$$

where V_c is the Volta contact potential difference between the observed metal and the receiver and $(V_s + V_c)$ is the actual potential difference between these two. Furthermore, energy considerations led Einstein to the relation

$$(V_c)_{12} = \varphi_1 - \varphi_2$$

that is, the contact potential difference between two metals is equal to the difference of their surface work functions, having proper regard to sign.

These four equations express all the results of classical and early quantum theory with respect to the photoelectric effect, and we must now briefly consider the results of experiment in relation to them. The first Einstein equation expresses a linear relation between the maximum energy of emitted electrons and the frequency of the light, and the slope of this line should be h. The most consistent determination of h by this method is that of Lukirsky and Prilezaev (1928), and the photoelectric method is one of the best available for the determination of h. The determination of h does not involve any specific characteristics of either the illuminated or receiving surface, but does of course require that these characteristics should remain fixed during any one determination. No matter how contaminated the surfaces are, if they remain constant, the correct value of h should result.

Early measurements of long wave limits for various metals were extremely discordant, and it only gradually came to be realized that the surface and volume conditions of the metal altered the limit and the related value of φ in a very marked way. Attempts to clean the surface produced such large changes that for a time a considerable group of experimenters held the

view that for a really clean metal surface there would be no photoelectric effect whatever. It is only in the last few years that it has been possible for different observers to get concordant results. That these observers, even with their extremely painstaking methods, are really dealing with perfectly clean gas-free surfaces is very difficult to prove. I am inclined to think, from indirect evidence, that in many cases they are, and to hope that the values of ν_0 (or φ) now being secured can later be correlated to other fundamental properties of the metals in a systematic way. However this may be, recent work shows a good agreement between the photoelectric and the thermionic work functions, if proper allowance is made for temperature variations, and the photoelectric and thermionic measurements are made on the same specimen. In a similar way, recent work confirms the predicted relation between V_c and φ, if again observations are made on the same specimen. Agreements between observations of V_c by the observer and the corresponding φs by another must be considered accidental unless the metals have in both cases been very carefully cleaned. But no matter how contaminated the surface, if V_c and $\varphi_1\varphi_2$ are measured under the same conditions, they are found to bear the theoretical relation to each other. The cleaning process, granted the metals are sufficiently free from metallic impurities, is largely concerned with the removal of gas from the surface and body of the metal, and for this only two methods have been successfully used, distillation and extreme heating in the highest possible vacuum. During the process of removing the gas, the long wave limit for a given metal may shift by as much as 1,000 Å. In some cases the shift is at first in one direction and then in the other, but such complicated effects are probably due not alone to the removal of gas but to other changes brought about simultaneously by the heat treatment. In the end (and this may be only after hundreds of hours of heating, or prolonged redistillation) surface conditions are reached which are almost completely stable as regards further treatment, and which change so slowly in the high vacua at room temperatures that accurate observations may be carried out upon them. It is such surfaces, if any, which may be said to be gas free.

The expression for the photoelectric current-density may be written

$$i_\nu = f(\nu)\, I \quad d\nu$$

where I_ν is the intensity of incident radiation of frequency ν, and $f(\nu)$ gives the dependence of photocurrent on frequency for unit incident intensity. Obviously $f(\nu)$ would be expected to depend on a number of factors, namely: the reflecting power of the surface for light; the index of absorption of the metal for light, as determining the penetration of the light into the metal; what is sometimes called the "quantum efficiency" or the probability that an available quantum will excite a photoelectron; the absorption coefficient for photoelectrons in the metal, and an internal reflection coefficient for such electrons at the metal surface. In spite of the complicated possibilities which these considerations suggest, it is found that for most metals $f(\nu)$ runs a simple course from zero at the long wave limit to continuously increasing values at higher frequencies. For the alkali and alkaline earth metals $f(\nu)$ usually shows a pronounced maximum which only appears, if the surface is specular, when observed at oblique incidence with the parallel ("dig-in") component of the electric vector (E). An effort has been made to separate these effects into two independent types of "selectivity," one the difference in the effectiveness of the perpendicular and parallel components of E, the other the occurrence of a maximum in the $f(\nu)$ curve. The situation is much more complicated than at first appeared; but, though the experimental evidence is in many cases conflicting, from the early work of Millikan and Souder and the recent work of Fleischer and Dember, Ives, and Suhrman and Theissing, it is possible to draw certain conclusions, which though not finally established seem most probable.

(1) The two selectivities, vectorial and spectral, are probably aspects of one phenomenon, the former being largely determined by the roughness of the surface. (2) Even with the alkali metals, the usual selectivity is absent when the metal surfaces are in what one might call their simplest condition if the observations are expressed as current per unit of *penetrating* light intensity. (3) The selectivity does not result merely from the adsorption of gas on such a simple surface, but as Ives suggested, from the development of an invisible surface structure, which may take weeks to appear. (4) The effect of this surface structure is not merely to alter the absorption characteristics for light, but also to change the intrinsic photoelectric properties. (5) These effects are much influenced by the thickness of the layer of alkaline metal which is being studied, but are relatively insensitive to gas contamination.

If we may hope to learn something about the nature of this surface structure and how it operates, then there is much more work to be done, involving dispersed illumination, simultaneous measurement of reflecting power and photoelectric characteristics, and X-ray study of the structure of the surface; though it may well be that the structure we are interested in is not deep enough to show by X-ray examination. There is needed either great elaboration of technique, or a considerable and clarifying innovation.

Recalling again the various factors which determine the normal run of $f(\nu)$, one might hope to separate these, which affect the velocity distribution as well as the number of emitted electrons, by a study of metal films of varying thickness, but such studies as carried out by Compton and Ross, Goldschmidt and Dember, Lukirsky and Prilezaev and Ives, have led to rather discordant results. This is not surprising when one considers not only the difficulty of measuring the thickness of very thin films, but also the difficulty of producing films which differ in thickness but are in other respects alike. From work with thin films the "mean free path" of the photo-excited electrons in metals is estimated at from 1 to 5×10^{-6} mm, while the thickness of the "active layer" or depth from which measurable numbers of photoelectrons can escape is in some cases put at 1×10^{-5} mm and in others as greater than 1×10^{-4} mm. In the nature of the case it is very difficult to free such films, once formed, from gas, and this is undoubtedly another reason for the discordant results. On the whole, work with thin films has been more successful in raising new questions than in answering old ones.

As directly observed, $f(\nu)$ is in terms of unit incident energy, and one would like to eliminate the effect of the optical properties of the metal in order to get nearer to the quantum efficiency or probability of excitation. With massive metals—*i.e.*, much thicker than the "active layer"—the outgassing develops a surface crystalline structure, and it is doubtful if the optical constants R and κ measured on polished surfaces are applicable to the multi-crystalline surface. Only a few attempts have been made to measure simultaneously the optical and the photoelectric properties. It is not surprising then that observations of $f(\nu)$ are discordant, and that no correlation between the $f(\nu)$ for various metals has been obtained.

There have been some experimental advances in recent years which, though somewhat qualitative in nature, are of decided interest. Of these consider first the influence of temperature, which might conceivably alter the long wave limit, the various factors determining $f(\nu)$, and the velocity distribution of the photoelectrons. It is important also to analyze the results from the standpoint of the probable cause, and it is usual to limit the term "temperature effect" to such as are *not* due to a change in a gas layer, or a definite allotropic change in the metal, though it is frequently not easy to eliminate changing gas conditions. In all, about a dozen metals have been studied with sufficient care so that some conclusion can be drawn concerning temperature variation, though for only a few metals do the results at all approach completeness. Generally, though not in all cases, the long wave limit moves toward longer wave-lengths with increasing temperature. In general also $f(\nu)$ changes —sometimes without any measurable change in the long wave limit. The most complete studies have been made of tantalum, gold, and silver by Messrs. Cardwell, Morris and Winch, and from their unpublished results I quote the most systematic example of temperature variation which has been found. If one plots the photo-current per unit incident light energy as a function of temperature for a series of discrete wave-lengths, then for all three of these metals one finds that for wave-lengths near the long wave limit there is a marked *increase* in current, while for those roughly 200 Å or more shorter than the long wave limit there is a less marked but definite *decrease* in current with rising temperature. Put in another way, the current-frequency curve $f(\nu)$ for high temperatures (600 to 800° C.) crosses that for room temperatures, the "toe" of the high temperature curve being more pronounced and the long wave limit less sharp and definite. Part of this systematic variation is foreshadowed in some earlier work of Ives with potassium and other alkali metals. That these systematic variations are real and not artifacts due to spectral impurity and the extremely rapid variation of sensitivity with wave-length near the limit, seems much more probable if one considers that two different dispersing systems—one double and one single—were used in the above work. As for interpretation, the *increase* in emission near the long wave limit and the extension of the "toe" of the curve is exactly what would be expected from the standpoint of increased kinetic energy of the conduction electrons from which the photoelectrons probably originate, but the *decrease* in emission for shorter wave-lengths would remain unaccounted for. Probably more complicated considerations are necessary, but in any event it appears to be a rather significant experimental result.

The study of the effect of temperature has brought out the effect of change in structure. The most marked changes are observed with iron, in which the $\alpha \rightarrow \beta$ and more particularly the $\beta \rightarrow \gamma$ transformations greatly alter the photoelectric characteristics. Cobalt shows at 850° C. changes very like those accompanying the $\beta \rightarrow \gamma$ transformation in iron, but the situation is more complicated, for resistance measurements indicate no transformation point at 850° C. but do indicate one at 450° C. which, however, does not appear photoelectrically. X-ray observations so far as they have been carried out agree with the photoelectric results in indicating a change in crystal structure at 850° C. Evidently the photoelectric effect and conduction are differently "structure-sensi-

tive," to use Goetz's term. Goetz has shown that the long wave limit increases progressively from β(2,740 Å) to γ(2,820 Å) to liquid (2,925) tin, but found *no* temperature change in photoelectric properties not associated with a change in structure.

All the work we have just been discussing has been done with multi-crystalline specimens, the study of single crystals, much to be desired, having been delayed by experimental difficulties. High melting point single crystals are difficult to produce, while low melting point single crystals would be either melted or recrystallized by the usual outgassing treatment. Unless this matter is very carefully considered, mistakes are likely to be made, and in particular it seems quite probable that different crystal faces might appear to be the same simply because the underlying characteristics are entirely concealed by gas contamination. On the other hand, positive evidence of a difference in the photoelectric behavior of different faces of a zinc single crystal, such as obtained by Linder, would appear to mean something even though outgassing precautions were not very carefully attended to. We have some preliminary evidence of a dependence of the long wave limit upon the crystal face, also in the case of zinc. In this case for the first time the crystals were grown in a very high vacuum, but were subsequently exposed to air for a short time. This is all that is known about the behavior of single crystals.

There is a general similarity in the behavior of metals during the outgassing heat treatment, to which attention may be called. Beginning with a surface condition resulting from rolling, annealing and mechanical cleaning by fine emery, the effect of the first heating is to cause a very considerable increase in general sensitivity, perhaps a hundredfold, followed by a more gradual decrease. During these changes the long wave limit shifts correspondingly, that is, toward long wave-lengths while the sensitivity is increasing, and toward short waves while the sensitivity is decreasing, indicating that at least the major part of the sensitivity changes are due to shifts in the long wave limit. During this part of the process, large amounts of gas are given off by the specimen. With most metals the final stage is reached by a gradual decrease in sensitivity to a steady value, the long wave limit becoming fixed at the same time. With iron and molybdenum, on the other hand, the final stage is reached by a further *increase* in sensitivity to a stable value. If air is admitted to the tube at any stage, the characteristics of the surface are changed to pretty closely their initial values. After such exposure a repetition of the heat treatment will, in a much shorter time, bring back values of long wave limit, etc., which had before been attained; but as far as our experience goes, the final condition is reached without passing through the original series of intermediate states. In other words, the heat treatment has produced a permanent change which is *not* reversed by mere exposure to gas. Whether this change is nothing more than the growth of fairly large crystal grains which are quite obvious to the eye, or whether it has to do with the removal of vaporizable metal impurities, or of gas from the body of the metal (the initial volume content of gas not having been reproduced by the relatively short re-exposure to gas which has been used) can not now be said. Probably all three factors—structure change, volume gas change and removal of impurities—have something to do with it. Work with single crystals should help to clear this up, and if once clean crystal faces can be obtained, a study of the effect of exposure to different gases should be of particular interest from the standpoint of the nature of the gas layers which are formed.

During the past few years there has been a decided revival of interest and activity in the electron theory of metals. Started by Sommerfeld, it has been carried on by Houstoun, Eckart, Fowler, Nordheim, Wentzel, and as regards our particular problem most recently by Frölich. The new theory, by the adoption of the Pauli exclusion principle (which may be described as social legislation to prevent overcrowding of the electrons) removes *a priori* the great difficulty with the older forms of the electron theory—namely, the specific heat paradox. According to the new picture, the valence electrons of the metal atoms become free in the solid state, but classical equipartition is given up and instead the energy distribution is given by the Pauli-Fermi-Dirac statistics, according to which the average electron energy is practically independent of temperature except at very high temperatures of the order of 10,000° C. At the absolute zero there would be a perfectly definite maximum electron kinetic energy (w_1), while at ordinary temperatures this maximum becomes less sharp and there is an approximately Maxwellian distribution over a short range period beyond w_1. For a metal having one free electron per atom, this maximum zero point energy corresponds to 7 or 8 volts. In dealing with the emission of electrons, the metal is treated as a *potential box*, and since the electrons are now given relatively large kinetic energies, the potential wall, w_a, of the box must be correspondingly higher than in the old theory, so that the difference $w_a - w_1$ will agree with the experimentally determined surface work function, φ. From the standpoint of the electrons we have played on them a typical protection-

ist trick—wages have been increased, but prices have gone up correspondingly, so that at first sight it might appear that we were no better off than before. There are however certain advantages, aside from the fundamentally important one of avoiding the specific heat paradox. The existence of velocities beyond the zero point maximum, the distribution curve rising with increasing temperature, leads to the conclusion that the long wave limit would be absolutely sharp only at the absolute zero, and that the *effective* or observed limit would shift toward long wave-lengths and become less sharp at higher temperatures. As we have seen, this is just what we have observed for tantalum, gold and silver, and it would be exceedingly interesting if these changes could be definitely connected with the predictions of the new statistics. At present we can not say whether the observed effects can be attributed solely to the temperature change in the electron velocity distribution.

The theory proceeds to consider the electrons in the potential box from the standpoint of wave mechanics, the effective minimum wave length of the electrons being of the order of a few Ångstroms. One immediate result is the computation of a *transmission coefficient* for electrons striking the potential wall, which depends upon the electron velocity and the height and form of the wall—that is, whether the potential change is sharp or gradual, whether the wall is flat or has a parapet, etc. For a given wall, and given *total* (kinetic plus potential) energy of the electrons, the transmission coefficient for internal electrons is theoretically the same as that for electrons approaching the surface from the outside. This gives an interesting opportunity to see whether transmission coefficients measured for electrons incident externally can be usefully applied to photoelectric and thermionic observations. Unfortunately, the theoretical transmission coefficient should differ from zero or unity only for a very narrow range of internal kinetic energies about equal to the height of the potential wall, and the kinetic energy of the corresponding external electrons would be of the order of a fraction of a volt. The determination of reflecting power for such slow external electrons is very difficult and up to the present there are no measurements available. If experimental values of the transmission coefficient could be obtained, then it might be possible to draw conclusions as to the form of the potential wall in specific cases, and this would be a most interesting result.

Of particular interest in relation to the surface electrostatic forces are the recent results of Suhrman, Becker and Mueller and Lawrence and Linford on the effect of external electric fields upon photoelectric characteristics. Working with the alkali metals it has been shown that relatively moderate external electric fields shift the long wave limit by considerable amounts, the effective value of φ changing by as much as 0.2 volt. Not only this, but the entire $f(\nu)$ curve is shifted toward longer wave-lengths, without change of form. This is quite in harmony with the theoretical view-point, according to which the form and effective height of the potential wall can be changed by the superposition of a sufficient external field. Furthermore, while a change in the potential wall should in general change the form of the $f(\nu)$ curve, the computed magnitude of this change turns out to be too smali to detect under the conditions of Lawrence and Linford's experiment.

The more detailed wave mechanical theory has arrived at two further conclusions which are very general and perhaps capable of experimental test. The first is Wentzel's deduction that $f(\nu)$, giving the photo-sensitivity for unit penetrating radiation as a function of frequency, should in *all cases* have a maximum, and the theoretically determined position of this maximum agrees fairly well with the position of the selective maxima for some of the alkali metals. At first thought this seems an extremely significant agreement, but there are two considerations which decidedly lessen our satisfaction. The first is the accumulation of evidence, which we have already discussed, which strongly supports the idea that the selective maxima of the alkali metals are *not* characteristic of the metals themselves but are due to little understood surface conditions, and the second is the fact that with several of the alkali metals the selective maxima are followed on the ultra-violet side by a rising sensitivity curve which is *not* predicted by theory. For other metals having their long wave limits farther in the ultra-violet, the theoretical selective maxima come at such short wave-lengths that it is not surprising that they have not yet been observed. It may be that the general predictions of the theory are correct, but that it is a mistake to attempt to correlate them with the commonly observed selective maxima of the alkali metals, and the most interesting test of this will be to push observations with the heavier metals farther into the ultra-violet to see if any evidence of the existence of a maximum sensitivity can be obtained.

More successful is the correlation of the theoretical velocity distribution of photoelectrons with the observations of Lukirsky and Prilezaev on thin films of silver. With decreasing film thickness the observed velocity distribution curve becomes qualitatively quite similar to the theoretical curve, showing a preponderant number of electrons having nearly the maximum velocity. Since the theory has been worked out

only for a thin layer, neglecting the absorption of light and electrons in the metal, this agreement appears significant.

As Wentzel is careful to say, the theory so far is so idealized that one must be cautious in attempting to correlate it with experiment. In simplifying the problem from the theoretical standpoint, several factors have been neglected which are just those which the experimenter can not, or at least has not, eliminated. Most important of these is the structure of the surface, which has theoretically been assumed to be *perfectly smooth*. It is doubtful whether experiment can ever deal with a surface approximating this condition. Furthermore, until values of the internal absorption coefficient for both light and electrons are available, either from experiment or from more fundamental theory, the present type of wave mechanical theory will be limited in its application to *thin films*. As we have seen, experimental work with thin films has its own peculiar difficulties, and the results in many cases show new complications rather than the simplifications which one would hope for in order to compare with theory.

The present situation then is that while experiment is providing continually more complicated results, though to be sure they are undoubtedly more reliable and more reproducible, theory naturally asks for simple characteristics obtained under idealized conditions. Perhaps with better controlled experiments and more elaborated theory, we can reach not only an understanding of the fundamental photoelectric process, but also, what is of equal interest and importance, a better picture of the structure of a metal surface and of the gas layers which form on it.

PSYCHOLOGY'S FAMILY RELATIONS AMONG THE SCIENCES[1]

By Professor MADISON BENTLEY

CORNELL UNIVERSITY, CHAIRMAN, DIVISION OF ANTHROPOLOGY AND PSYCHOLOGY, NATIONAL RESEARCH COUNCIL

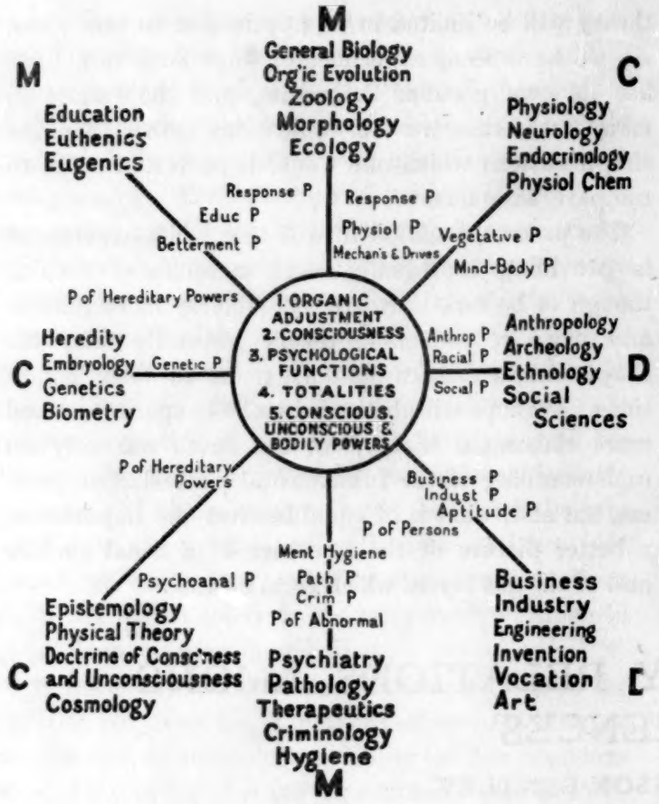
SCIENCES, like families, have their lines of descent. In some the ancestral strains are easily to be traced; in others the derivation is clouded by uncertainty or complicated by strange infusions. Some of the older sciences derive with great directness and simplicity from remote cosmogonies and philosophies; but the younger members often branch widely in process of generation, going back to disparate sources and interlacing with many other lines. For the contrast you have only to compare chemistry and biochemistry, physics and endocrinology.

Like the average family, again, the science possesses a large number of collateral relations. It has its brethren in other sciences, its cousins and nephews among the professions, and numerous legal kin acquired by solemn union with the arts and vocations. No occasion in the year so inevitably brings out these collateral relations as does the great winter pilgrimage of our tribes of the Triple-A to the common Mecca of the Faithful. Here we find many evidences of our familial ties and of our close fraternal dependencies; our intersectional interests, our passionate allegiance to the virginal mother, our implicit trust in the beneficent guidance of the Council of the Elders, our frigid intersectional shuttling from door to door in wintry blasts, our hybrid conferences, and our embracing symposia.

[1] Address of the retiring vice-president and chairman of Section I—Psychology, American Association for the Advancement of Science, Cleveland, January 2, 1931.

But the individual subject may itself be aptly used to exemplify the same sort of horizontal membering. Take psychology. It is not easy to enclose within a single central area all that is named by that name. And when we look beyond the more immediate boundaries, we observe a large number of widely radiating lines leading first toward a number of psychological specialties and ultimately to other collateral subjects each with its own family seat but each maintaining an intimate relation with psychology. These lines run outward from our own central domain toward general biology, zoology and ecology; toward physiology, neurology and endocrinology; toward anthropology, ethnology and sociology; toward business, vocation and industry; toward medicine, criminology and hygiene; toward physical and cosmological theories and doctrines of mind and matter; toward heredity, embryology and genetics; and, finally (if the long list may be completed), to education and human betterment. Add a multitude of cross-threads running helter-skelter throughout the figure and you have a gross representation of the great psychological family as it greets the New Year of 1931.

Now it is necessary that the inner circle of psychology be drawn wide enough to make room upon its convexity for all these centrifugal connections. But it is obvious upon inspection that the wide diameter has not been arbitrarily chosen. It has of necessity to embrace the existing schools and basal varieties.



These latter are many because of the wide range of outside interests, and the outside interests are multiform because psychologists variously envisage and variously develop their own subject. These two geometrical aspects are, then, wholly correlative, and they are derived from one and the same historical setting. For three decades at least psychologists have been reaching out to touch knowledge, the arts, the professions, and the affairs of every-day living. And at the same time all these human interests have been pressing in upon psychology, implicitly confessing that man's learning and man's living require facts and principles not otherwise supplied in the curriculum of the sciences.

Let it be observed that, in spite of this entanglement in the collateral lines, our outside connections, while many, are not wholly disordered. We count our brethren among the biologists, the neurologists and the students of early man; our cousins among the biometrists, therapeutists and promoters of hygiene; and our more distant relatives-by-adoption among such diverse strains of kinship as the historians of the law and of custom, the acoustical and optical engineers, personnel researchers and physicists speculating upon the nature of the cosmos.

Again, these connections imply certain distinctive attitudes assumed by our brethren toward their younger, psychological sibling. The first of these attitudes is one of active solicitude and suggestion. It has been conspicuous in three quarters, general biology, education and medicine. All three brethren have shown a willingness to conduct and to care for the affairs of psychology. Let us call these the *managing* relatives (M). So deeply have they set their mark that many observers have, in passing by, regarded psychology as a mere branch of biology, a mere convenience of education, or a mere application of medicine to mind. Three other consociated groups are *contributing* relatives (C). Present psychology would not be possible without the contributions generously made to it by physiology, bodily history and reflective theory. Every one who deals broadly with the living organism must know the body's functional devices and the body's mode of derivation and development. For general theory and speculative assumptions the empirical sciences have less use, and psychology can well afford to reduce still further her family intimacies in that direction; but as matters stand to-day that source of contributions can not be ignored. The chief *dependent* relatives (D) are two: the one the group of social studies and the other the practical and technical group at the southeast corner of the figure; the one depending upon psychology for a depiction of the socialized organism at work and the other for methods and means of estimating and measuring human differences in production and accomplishment.

Neither are we wanting in those more intimate and irregular relations which sometimes threaten to disrupt the smooth convexity of the family circle. The union of psychology and anthropology was formally recognized in our companionate Section H, but later dissolved by a decree of our discrete Council of Elders, restoring to both parties their singular freedoms. The case was not complicated by offspring; but fruitful relations have since been resumed between anthropology and psychology, and a whole chain of A and P trading-posts has now sprung up, the most conspicuous among them all to be found in our Division of the National Research Council. The fact that one individual—be he A or P—is now annually selected to nourish this bilingual offspring would seem to provide a practical sanction for such informal conditions of hybrid union.

We have also our frank illegitimacies, as certain irreconcilable behaviorists once disclosed. Apparently bred from biology, but eager to claim another birthright and bold to adopt another family name, the behavioristic pretender threatened to crowd all other fledglings from the nest. Fortunately the nest was widened by the aggressive intruder and his behavior has been gradually improved by more disciplined mates. The reformation is now cited to establish the conquest of hereditary taint and to prove that, no

matter how bad the egg, a good environment may suffice to make a decent bird.

Among those orphaned offspring of strange alliances which have been adopted by psychology stand that issue of metaphysics and medicine which still answers at times to the name of Freud and that other issue of epistemology and sociology which came to us under the alias of *Phänomenologie* and now proposes to prefix the Christian name "Social" to our family title.

The inseminating powers of the word in creating new members of a family group are well illustrated by anthroponomy and functionalism, and by a whole group of qualifiers which includes hormic, dynamic, reflexological, individual and biosocial.

Had ever a sober discipline so many relatives and so thorny a family tree? Or is psychology not sober? And does "discipline" less name her than name her needs? Have loose company and tight companions given her landscape an apparent rotatory blur? Is it all a temporary amblyopia? Or is her difficulty fixed in the genes and so predestined to disfigure her progeny?

Soon psychology must seriously consider the f_1 generation. With so many present alliances, exogamous and incestuous, and so many legal and irregular adoptions into family intimacy, provision against the future will presently become urgent. Naming the offspring will itself prove to be a task. There will be the little son who experts for the automobile-assembling crew, and others who control the efficient pasting of bottle labels and the making of soups. Wall-Street psychologists are coming on in litters, and so are the precocious advertising prophets, psycho-physicians to domestic disharmony, experts attached to football coaches, vocational horoscopists in nursery schools, and many other specialists. Each little psychologist must have his proper Christian name lest he develop an inferiority during his impressionable years.

But all that anxiety about the new brood may be left to the future. Sufficient unto the day. . . . Nor should we be disturbed by a recent rumor, imported from abroad, that psychology is a "curse." Our multiplicity of kinds and of tasks may have suggested to the uninformed that we are muddled or futile; but only a comedian designing a travesty or a zealot kindled by emotion would travel overseas to persuade the intelligent that psychology possesses the blighting power of the witch. Possibly we shall find that the query has mistaken psychology for some temporary cult current in another land or that it is only a jest turned to account for the pockets of clever debaters.

Our immediate concern is for

> The worried old lady, at sea in the blue,
> Who has so many collaterals
> She doesn't know what to do.

Some of our stricter monogamists offer simple remedies. "Connect sense organ and muscle," says one, "and christen them the Reflex Couple." "Body and mind," declares a second, "were eternally conjoined. Let no pagan put them asunder." "On the contrary," counsels a third, "divorce them, annihilate mind, and set a strict watch upon the future behavior of the liberated body." "If you will but give Psyche new glands," cries the plastic surgeon, "a new libido will appear and will instinctively select a proper mate." "Bring her to church with anthropology, with ethnology, education, sociology, medicine, hygiene," shouts the crowd of self-appointed advisers, "and have her respectably and usefully conjugated."

Now it is an astonishing fact that all this gratuitous advice has actually been offered and, in certain quarters, actually accepted. You have only to examine the writings of the psychological family during the past year to discover that each of these ligations has somewhere been assumed and turned to account. The result is striking. A large part of the literary product of the year and of other recent years lies in the great intermediate region bordering upon the periphery of our figure. So much, in fact, is in the periphery that it sometimes appears that psychology is chiefly a medley of interests and relations, without independent status, extending freely from biology on the one side to medicine on the other, from neurology to neurotics, from heredity to eugenics, and from instincts to social institutions, with only a colored vacuum to mark the central nexus of cross-reference. If we are not such a medley, it may be worth our while to encourage the accumulation of substance in the colored vacuum and thereby to consolidate our central field. It may well be doubted whether a subject which cultivates the title of science can long continue to do more than journeyman's jobs outside unless it has its own common principles and its distinctive subject-matter.

Possibly we should improve our perspective by asking as many of the relatives of psychology as bear the name of science to give us their views of our own subject. Relatives are notoriously frank and plain of speech. If we did, however, we should not find it easy to ignore the non-scientific members of the family group; education, medical arts, eugenics, human betterment, social and industrial practice, and the vocations. The heavy dependence of psychology upon these is readily to be seen when they are removed from the field. Psychology as it is now professed would certainly change its perspective without

their support. But the appropriate inquiry of the hour more specifically concerns the sciences. To these we must briefly turn.

At once we discover that the reference inward toward psychology from any one of the outlying sciences is generally toward some one particular variety, and not to the subject at large. Thus the group at the top, the biological group, stands related to that form or variety of psychology indicated by organic adjustment. For this there are two reasons. The first is that the fundamental doctrine of adjustment falls under biological theory. The second is that the emphasis here placed upon animal behavior is an ecological offshoot of zoology. It is chiefly among psychologists of this temper that the management and exploitation of their field by the biologists has been condoned. In a similar way, the lower center (conscious, unconscious and bodily powers) has been primarily directed and exploited by the medical cousins, uncles and aunts, with an added doctrinal importation from the speculative group in the extreme southwest. It is obvious, moreover, that the psychologists of consciousness and totality have also received large gifts from doctrinal and theoretical sources. At the same time, both these latter psychologies tend now to be more and more independent of these elder relatives and therefore more and more genuinely psychological.

It is interesting to observe that the hereditary group at the left has contributed to every central phase of psychology. Organic adjustment draws thence a genetic account in its own biological terms; consciousness sees itself individually developing upon a native organic base; the psychological functions imply stock as an enduring factor operative throughout life; totalities refer backward to primitive structures of figure-and-ground demanding bodily heritage and development; and the forces put to psychoanalytic uses imply both a bodily heritage and either an organic or a mental unfoldment. In a word, no general psychology has yet succeeded in our times without laying a basis in heredity and organic development.

On the side of the dependent relatives, it is clear that the backward reference toward psychology has usually been made toward a single central type. Thus the business group has usually drawn upon the doctrine of organic adjustment; though its methods have commonly come through the minor eccentric groups of educational psychology and the psychology of hereditary powers, thus deriving ultimately from tests and the statistical schools of biometry and genetics. Its debt is primarily to education and the biological sciences, however much it has received gifts at second-hand through these intermediating tradesmen. It has been only slightly tinctured by the central principles, facts and methods of psychology.

The anthropological and social dependence is more varied and more ambiguous. That large group comes groping to psychology not quite knowing what it wants in that direction and still less clear as to what it can get. Both uncertainties may very well indicate that the psychologies of the present are not prepared to serve the social studies. Sociology has had to be satisfied with its half-breed cousin christened social psychology and by an adoption of psychology's borrowed phrases about heredity and environment, instincts and dispositions, group-behavior and implicit responses. Cultural anthropology draws more variously, seeking with greater precision for psychological factors and causes to clarify the origin and the significance of its cultural products, *i.e.*, language, custom, ceremonial, manufacture, and the rest. Here is a legitimate want which psychology might well seek to satisfy by first acquiring a more empirical view of human socialization and then testing its view by an examination of those processes and resources by which man has produced the cultural objects. Until now she has created no body of fact and doctrine which is adequate to the great demands of cultural anthropology. Physical anthropology is still untouched by its psychological relations, and the anthropologist of human beginnings has been too closely engaged with the geologist and the comparative anatomist to trouble himself with psychological vagaries suggested by the naked fragments which he has turned up in cave and gravel wash. Finally, the anthropologists of the Galtonian type have, in their inquiries into human faculty, contented themselves with methods more biometric and educational than psychological, though sometimes couched in terms of the psychological functions.

The special and partial psychologies which lie scattered about the face of our figure are curious members of our large family. They must be counted with the f_1 progeny, for they derive, each and all, from a cross between the central member and a non-psychological parent. Do you not agree that they all stand, in point of resemblance, nearer the peripheral sire; educational psychology nearer education, social nearer the social sciences, psychoanalytic nearer medicine and metaphysics, vegetative nearer neurology, physiological nearer physiology, and the various psychologies of personality nearer the gross arts of every-day living? The prepotency of the non-psychological parent seems to me to be evident in their manner of operation and in their results, a fact which may be used to suggest a very important commentary upon the existing state of psychology, which has acquired

the knack of reflecting, as it moves, the variegated coloring of its surroundings. Psychology comes near to being all things to all environing sciences and to all human arts. Its services are too much those of a jack-of-all-trades, who has many facilities but no profession.

That is our state; but fortunately it is not our tendency. Our subject lacks central cohesion and organization. Its representative schools are too many and too various. They have had of late but meager means of exchange and few common interests and goals. That is the inevitable result of the last quarter of a century in the study of life and society and in business and industry. But I think that the state is changing. Signs of integration are not wanting. No one of our five centers in the figure is so impervious and so self-contained as it was ten years ago. Their dialects are acquiring more and more common terms and phrases. There is more tolerance and more give-and-take. More researches pass current in all centers. It appears that the processes of fusion and consolidation are waxing, and that, on the other side, psychology is tending away from the encompassing disciplines and interests. The time may therefore come when it will not be chiefly a minor branch of biology, a medical clinic for the disordered and the introverted, a testing room for education and the juvenile court, a meeting place for neurological vagaries, a cataloguer of social epithets, a diviner of vocations, and a fad of the curious. Diversity of tasks and multiplicity of interests are impressive signs of life and energy; but they do not take the place of central principles, common hypotheses and attested methods of research, all indications of sanity which can not safely be replaced by a common name, registration in a common directory, and adherence to a common section in the associated sciences. As psychology values more and more its independence, husbands more and more its unique resources, and clarifies more and more its proper relations among the sciences, it will, as I believe, deal more frankly and competently with certain functions and performances of the living organism which at present fall to the lot of no distinctive member of the whole large family of the sciences.

OBITUARY

MEMORIALS

THE late Dr. Bashford Dean, founder of the Department of Fishes in the American Museum of Natural History, and at the time of his death in December, 1928, honorary curator of ichthyology, left behind him a number of sets of magnificent unpublished drawings illustrating the embryology of three of the lowest fishes. His materials and drawings are being worked up by certain of his associates and former students, and the resulting papers will be published by the museum in parts as finished as "The Bashford Dean Memorial Volume—Archaic Fishes" in quarto size under the editorship of Dr. Eugene W. Gudger, bibliographer and associate in ichthyology. The first article, a "Memorial Sketch" by Dr. William K. Gregory, a former student of Dr. Dean and his successor as curator of ichthyology, was published on December 15. It consists of a twenty-two page sketch of Dr. Dean's life and work, divided into sections to show on what subjects he was working at various times. This is illustrated by a photograph and five half-tone portraits. Next there is a complete bibliography of Dr. Dean's writings comprising 315 titles. At the end are appendices containing lists of other memorial sketches, copies of resolutions and memorial minutes adopted by various organizations, and reports of the opening of memorial and research rooms and exhibits dedicated to Dr. Dean in both the Metropolitan Museum of Art and the American Museum of Natural History. This is illustrated by photographs of the memorial tablets in the two museums and by two other figures. This Article I of the Memorial Volume comprises forty-two pages, and has eight plates and two text-figures.

IN memory of Dr. William Diller Matthew, professor of paleontology, who died at the University of California on September 24, members of the faculty have arranged to give a series of seminars or discussions on paleogeography this spring, starting on January 21.

The first seminar will be led by Dr. Charles L. Camp, curator of reptiles and amphibians, who will review Dr. Matthew's book, "Climate and Evolution." Other men who will lead seminars are: R. W. Chaney, curator of paleobotany; Dr. B. L. Clark, professor of paleontology; Assistant Professor N. E. Hinds and Professor G. D. Louderback, of the geology department; Professor C. O. Sauer and Assistant Professor J. B. Leighly, of the geography department; Professor W. A. Setchell, Professor W. L. Jepson and H. L. Mason, of the botany department; Dr. H. M. Hall, of the Carnegie Institution, Washington, D. C.; Dr. Alden Miller, zoology department; Professor E. C. Van Dyke, entomology department; Professor T. Wayland Vaughan, director of the Scripps Institution of Oceanography, and Dr. C. E. Weaver, of the University of Oregon.

RECENT DEATHS

DR. RICHARD BISHOP MOORE, dean of the College of Chemistry of Purdue University, and an authority on the use of radium in treating disease, died on January 20. Dr. Moore was fifty-nine years old.

ELMER HOWARD LOOMIS, professor emeritus of physics at Princeton University, died on January 22, at the age of sixty-nine years.

DR. OREN HOWARD COBB, for the last eighteen years superintendent of the Syracuse State School for Mental Defectives, died on January 24. He was fifty years old.

MR. JOHN CLACEY, for many years optician at the National Bureau of Standards, died on January 12 at Washington, D. C. Mr. Clacey was one of the last of the old school of opticians, and before joining the staff of the bureau made many of the fine lenses in use in observatories of this country and abroad. Among the historical instruments made by Mr. Clacey is Chandler's almucantar with which the discovery of the variation of latitude was made. A brief account of his career appeared in *Popular Astronomy* for October, 1930.

Nature reports the following deaths: A. A. T. Brachet, For.Mem.R.S., rector of the University of Brussels, and director of the laboratory of embryology of the faculty of medicine in the university, aged sixty-one years; Major E. A. FitzGerald, author of "Climbs in the New Zealand Alps" and "The Highest Andes," on January 2, aged fifty-nine years; Professor Hans Kniep, director of the Institute of Plant Physiology at Berlin-Dahlem, on November 17, aged forty-nine years; Mr. H. A. Lowe, honorary fellow of the Textile Institute, who discovered in 1899 the process of "tensioning" mercerized cotton fiber on December 26, and Professor T. Wibberley, formerly Harrington professor of agricultural research, University College, Cork, who was known for his work on the breeding and introduction of new varieties of oats and wheat, on December 22, aged fifty years.

SCIENTIFIC EVENTS

CALENDAR REFORM

THE London correspondent of the *Christian Science Monitor* reports that the Council of the League of Nations has decided to invite all nations to discuss simplification of the calendar by international conference on October 26 next.

The three undisputed defects of the present calendar are: Unequal months, changing of week-day names for monthly dates, drifting dates for Easter and other church festivals.

The method which has found most approval is the division of the year into 13 months of 28 days each (the odd day to be an additional public holiday).

Every month would then be like February, 1931, in which the four Sundays fall on 1, 8, 15, 22 and the month is one of four weeks. Every fourth year Leap-day instead of being on February 29 would be in summer on June 29. The year-day, that is, the odd day of the 13 months, would be on December 29, and Christmas Day and holidays would all be fixed for Mondays, thus giving the workers the benefit of long week-ends.

By absorbing the last 13 days of June and the first 15 days of July the 28-day month would gather up all twenty-ninth, thirtieth and thirty-first days. All church festivals would be fixed, Easter Sunday being always on April 15 and Whitsunday on June 8.

Every month would therefore have a permanent economic value. The day of the week would always indicate the monthly date, and *vice versa*. Pay days, markets and meetings would recur on the same monthly dates. Weekly wages and expenses would be harmonized with monthly rents and accounts. Accounts and drafts would never fall due on Sundays. Permanent monthly dates for recurring fixtures in all walks of life would be established. All periods for earning or spending would be either equal or exact multiples of each other. Every month-end would coincide with the week-end most conveniently for business, rents and general affairs. Great statistical advantages would be secured by the ability to truly measure current fluctuations in government, export and business affairs.

A report of the national committee of the United States gives a percentage of 98.3 in favor of the 13 month calendar. This figure is obtained from a questionnaire submitted to 480 organizations. A number of large concerns both in Britain and the United States use private simplified calendars of 13 periods and 4-week months of 28 days.

In Germany there is evidence of much interest in calendar reform and Professor Erich Przybyllok, the Königsberg astronomer, has declared that little can be achieved without a publicity campaign. He finds all the Protestant churches in favor of reform; Jewish orthodox circles are agreeable to any change acceptable to the majority; the Roman Catholic Church is apparently against all alteration. He is of opinion that once the public understands the great advantages to be gained the weight of feeling will bring about the change.

THE MARSHALL FIELD ARCHEOLOGICAL EXPEDITION

AN expedition which will excavate ancient Maya sites and collect artifacts representing the highest of aboriginal American cultures, search an uninhabited and almost impenetrable forest region for hitherto uncovered Maya cities, and study the Indians of modern Maya tribes by living for a period among them, left Chicago on January 21 on behalf of Field Museum of Natural History. On January 23 the expedition sailed from New Orleans aboard the steamship *Coppename* for British Honduras and Guatemala, where operations are to be conducted, it was announced by Stephen C. Simms, director of the museum.

This is the third Marshall Field Archeological Expedition to British Honduras, and it is to be led by J. Eric Thompson, assistant curator in charge of Central and South American archeology at the museum. Mr. Thompson led two previous expeditions sponsored by Mr. Marshall Field, as well as other exploring parties in this territory, and has written several books on ancient and modern Maya culture. The present expedition has a wider scope of operations than those which preceded it.

After landing at Belize, the expedition will proceed by boat up the coast to the mouth of the New River, and thence inland on the river to the head of navigation. Thence by mule pack train and on foot for many miles the journey will continue to the ancient city of Kax Unuic (Maya name meaning "Man of the Woods") which is situated on the frontier between British Honduras and Guatemala. There, with a party of Maya diggers recruited from among the native inhabitants, certain ruins will be excavated which promise to yield a rich collection of Maya antiquities for the museum, probably dating back to a time approximately coincident with the beginning of the Christian era or earlier.

When this work has been completed, the expedition will transfer its activities to the southeast Peten district of Guatemala, where reconnaissance work will be carried on through an extremely dense tropical forest region, uninhabited for many years, in search of the sites of ancient Maya cities known to exist but hitherto never definitely located. Work here will be entirely on foot, as the trails are too poor to take mules. The assistance of natives living on the edge of the forest, who are believed to have knowledge of the approximate location of the ruins, will be solicited. It is hoped that a number of old monuments bearing dates in Maya hieroglyphics will be found on the surface in the locality of the buried ruins. The explorations in this territory are a part of the expedition's work which is made possible by funds contributed by the Carnegie Institution of Washington, D. C.

Finally the expedition will pitch camp in the highlands of Guatemala to conduct ethnological work among certain modern Maya tribes. By living among these people and observing their ways of life it is expected that much new information will be obtained, and that it will be possible to trace many of the present customs back to the culture of the early Mayas. The expedition will be in the field probably about six or seven months.

THE AZTEC RUINS NATIONAL MONUMENT

PREHISTORIC Indian ruins of the pueblo type have been added to the Aztec Ruins National Monument, New Mexico, by the recent proclamation of President Hoover adding over eight acres to the reservation. The total area of the monument is now approximately 26 acres.

Two tracts of land comprise the addition. One, embracing 1.8 acres, was owned by the American Museum of Natural History, and donated by it to the government. It was through the generosity of one of the museum trustees, Mr. Archer M. Huntington, that the original area of the monument, amounting to 4.6 acres, was presented to the United States for monument purposes.

Later, in 1928, the Museum of Natural History donated an additional area of 12.6 acres which was added to the monument. Long before the establishment of the monument, the American Museum had conducted extensive archeological explorations in the area under the direction of Dr. Earl H. Morris, who was instrumental in obtaining scientific recognition of the value of its prehistoric ruins.

The other tract of land, containing about seven acres, was purchased by the government through the cooperation of W. T. Grant, of New York City, who donated $750, or half the purchase price, to the National Park Service for this purpose. The remainder of the cost was borne by the government appropriation, which provides for the acquisition of private lands in connection with national parks, provided half the cost is contributed from private sources.

The main feature of the Aztec Ruins National Monument is a large E-shaped pueblo structure containing approximately 500 rooms. The first floor of this structure is standing and in 24 of the rooms original ceilings are intact. In many places the walls of second-story rooms are standing, and in some cases also parts of third-story rooms. The ceilings, where in place, are supported by large beams, cut and dressed with stone tools. They are exhibits of work done in the Stone Age, while the sandstone walls, reasonably

plumb and with dressed faces, take high rank as examples of prehistoric masonry.

A museum collection has been installed in six of the excavated rooms in the old building. The nucleus of the material in it is a loan from the American Museum of Natural History. In addition, several hundred specimens have been donated by local people.

THE NEW YORK STATE FOREST RESEARCH INSTITUTE

THE New York State Forest Research Institute, as a division of the work of the New York State College of Forestry, was established by action of the board of trustees at a meeting held in December. The objective in the establishment of the institute is to give the work in forest research now carried on by the college in different sections of the state a definite entity and more effective direction.

Research in forestry in New York is authorized under the charter given the college by the legislature of the state. The board of trustees during the past eighteen years have, in carrying out the obligations of the charter, set up special divisions of the college, such as the State Ranger School at Wanakena, the Roosevelt Wild Life Forest Experiment Station and various other experiment stations.

The purpose of the trustees in establishing, at this time, the State Forest Research Institute is to so coordinate forest research as now carried on by and through the college that the results may be applied in a more practical way to the practice of forestry in the state, but particularly in private and public reforestation which is now being done on a large and aggressive scale.

The plan for the Research Institute was presented to the board of trustees by Dean Hugh P. Baker, of the college. The institute will bring into more effective direction and cooperation several college agencies now operating somewhat independently. The program of the institute will be worked out by and through the college faculty. Mr. Clifford H. Foster, director of the Pack Demonstration Forest near Warrensburg, New York, is to be acting director of the institute.

Forest research is now being done on the Ranger School Forest of 2,300 acres at Wanakena near Cranberry Lake in the western Adirondacks; at the Pack Demonstration Forest of 2,400 acres near Warrensburg, New York; at the State Forest Experiment Station in Syracuse; on the lands owned by the college near Salamanca in Cattaraugus County, and by other divisions of the college. All these activities will be coordinated and directed under a single head.

That the state-wide reforestation program now in progress under the direction of the Conservation Department might be definitely assisted by results secured from centralized forest research was indicated by Dean Baker in presenting the plan to the trustees. It is, therefore, important to have this particular phase of forestry in New York given a definite entity and centralized at the institution whose charter from the state obligates it to carry on such work. The centralization of this endeavor at the College of Forestry at Syracuse should result in more comprehensive forest research than formerly, particularly as this work is now being carried on under appropriations supplied by the state for forest investigations. In the aggregate a considerable sum of money is being devoted to forest research by the state, but on account of the unrelated direction of this work there has been some overlapping and duplication.

THE INTERNATIONAL CONGRESS ON ILLUMINATION

THE International Congress on Illumination will be held in Great Britain from September 2 to September 19, inclusive. It will bring together scientific men and engineers from the leading countries of the world and will provide for the exchange of scientific data and other information relating to the more important phases of lighting practice. Austria, Belgium, Czechoslovakia, France, Germany, Great Britain, Holland, Hungary, Italy, Japan, Sweden, Switzerland and the United States are represented on the International Commission on Illumination.

The technical sessions of the congress will be held in several cities, thus interspersing travel with the study of lighting problems. Registration for the congress will take place in London on the first three days of September, during which time a reception will be held and visits made to places of technical interest, according to the Hon. Secretary of the Congress, Col. C. H. S. Evans, of the British Illuminating Engineering Society. The first session will be held on September 4 in Glasgow. Meetings and visits to points of interest will follow in Edinburgh on September 6, 7 and 8; Sheffield, September 9 and 10; Birmingham, September 11 and 12, while on September 13 a tour will be made from Birmingham to Cambridge. The various technical meetings and plenary session of the International Commission on Illumination will be held at Trinity College, Cambridge, from September 14 to 19, inclusive.

The dates have been chosen to enable the delegates to attend the three-day celebration in London of the Faraday Centennial, immediately following the congress. The centennial includes a meeting of the Institution of Electrical Engineers and will be followed in turn by the annual meeting of the British Association for the Advancement of Science.

The following topics have been designated places of

importance on the papers program and discussion periods to take place at Cambridge: Factory, Office and Home Lighting, Aviation, Lighthouses and Buoys, Street Lighting, Traffic and Motor Vehicle Lighting, Floodlighting, Architectural Lighting, Natural Lighting, Laboratory Technique, Mine Lighting, Museum Lighting and Lighting Bureaus.

The U. S. National Committee of the International Commission has been charged with the responsibility of management and direction for four important divisions of the commission's activities. These are: Motor Vehicle Lighting, Factory and School Lighting, Aviation Lighting and Applied Lighting Practice in fields not otherwise specifically assigned. The need for agreement on some essential features of aviation lighting has already resulted in preliminary meetings abroad under the auspices of the International Commission and the forthcoming meetings will undoubtedly bring together important specialists in this newer field of lighting.

The American contributions to the papers program are under the supervision of a committee composed of Mr. A. L. Powell, of the General Electric Lighting Institute, Harrison, New Jersey; Dr. C. H. Sharp, Electrical Testing Laboratories, New York; H. H. Magdsick, Nela Park Engineering Department, Cleveland; F. C. Hingsburg, Airways Division, Department of Commerce, Washington, D. C.; E. C. Crittenden, Bureau of Standards, Washington, D. C.; L. A. S. Wood, Westinghouse Electric and Manufacturing Company, Cleveland, and G. H. Stickney, General Electric Company, Nela Park, Cleveland.

Members of engineering societies and others interested in the science and art of illumination are eligible to attend the congress. Those interested are requested to register as soon as possible by application to the Assistant Secretary of the Illuminating Engineering Society, 29 West 39th Street, New York City.

The officers of the U. S. National Committee are: *President,* E. C. Crittenden; *Secretary-treasurer,* G. H. Stickney. The membership includes representatives of the following societies: American Institute of Electrical Engineers, Illuminating Engineering Society, National Electric Light Association, American Physical Society, Bureau of Standards and the Optical Society of America.

The attendance and transportation committee for the congress includes Dr. C. H. Sharp, chairman; J. W. Barker, dean of engineering, Columbia University, and S. E. Doane, consulting engineer, New York City.

SCIENTIFIC NOTES AND NEWS

DR. W. W. KEEN, emeritus professor of surgery at the Jefferson Medical College, Philadelphia, celebrated his ninety-fourth birthday on January 19.

MR. THOMAS EDISON will celebrate his eighty-fourth birthday on February 11. He left last week for Fort Myers, Florida, where he expects to continue his work on rubber from native plants.

THE Willard Gibbs Medal for 1931 has been awarded by the Chicago section of the American Chemical Society to Dr. Phoebus A. Levene of the Rockefeller Institute for Medical Research "as the outstanding American worker in the application of organic chemistry to biological problems." The citation eulogizes Dr. Levene for his studies in nucleic acid, amino sugars, lecithins, cephalins, fatty acids, cerebrosides, inorganic esters of sugars, thiosugars in yeasts, hydroxy acids, and amino acids, as well as for his work in stereochemistry. Dr. Levene will be the twentieth recipient of the medal at a formal ceremony to be held later in Chicago. Previous medalists have been Svante Arrhenius, of Sweden; Madame Curie, of France; Sir James C. Irvine, of Scotland, and the following Americans: T. W. Richards, L. H. Baekeland, Ira Remsen, Arthur A. Noyes, Willis R. Whitney, E. W. Morley, W. M. Burton, W. A. Noyes, F. G. Cottrell, J. Stieglitz, G. N. Lewis, M. Gomberg, J. J. Abel, W. D. Harkins, Claude S. Hudson and Irving Langmuir.

IT is announced that Sir Ernest Rutherford who was raised to a peerage in the British New Year's Honors List will henceforth be known as Lord Rutherford.

THE council of the Royal Astronomical Society has awarded its gold medal to Professor W. de Sitter, director of the Leiden Observatory, for his theoretical investigations on the orbits of the satellites of Jupiter, and his contributions to the theory of relativity. A Jackson-Gwilt Medal and Gift is awarded to Mr. Clyde W. Tombaugh, Lowell Observatory, Flagstaff, Arizona, in recognition of his discovery of Pluto.

DR. KURT RUMMEL, of Warmestelle, Dusseldorf, was presented with the Melchett Medal, awarded by the British Institute of Fuel, by the president, Sir David Milne Watson, at the Institute of Civil Engineers on January 23. The medal was instituted by the late Lord Melchett, founder-president of the Institute of Fuel.

DR. DAVID MARINE, assistant professor of pathol-

ogy at the College of Physicians and Surgeons of Columbia University since 1920, and director of laboratories at Montefiore Hospital, was presented with the gold medal of the New York Academy of Medicine on January 7, for his research into the structure, functions and diseases of the thyroid gland. Dr. Marine was unable to attend the ceremony on account of illness.

AT the Cleveland meeting, the American Society of Parasitologists elected its first group of foreign honorary members as follows: Emile Brumpt, France; Otto Fuhrmann, Switzerland; Akira Fujinami, Japan; Friedrich Fülleborn, Germany; G. H. F. Nuttall, England; Edoardo Perroncito, Italy, and Arnold Theiler, South Africa.

THE Chilean Nitrate of Soda Nitrogen Research Award of $5,000, administered by the American Society of Agronomy, was, at the recent meeting of the society in Washington, divided equally among Dr. J. J. Skinner, senior biochemist of the Bureau of Chemistry and Soils, U. S. Department of Agriculture; Professor L. G. Willis, soil chemist of the North Carolina Experiment Station, and Dr. James K. Wilson, professor of soil technology, Cornell University.

AN exhibit of reproductions from x-rays prepared by Clinical Professor Harold Brunn and Instructor Selling Brill, in the J. J. and Nettie Mack Thoracic Surgery Clinic of the University of California, has been awarded first prize by the Scientific Section of the Radiological Society of America.

MR. FRANCIS LEE STUART, consulting engineer, of New York City, was inducted as president of the American Society of Civil Engineers at the opening session of its annual meeting on January 14.

DR. VICTOR G. HEISER, of the Rockefeller Foundation, was elected president of the newly organized International Leprosy Association at the meeting in Manila of the Congress of Leprologists, which adjourned on January 22; the vice-presidents, Dr. Chagas, of Brazil, and Dr. E. Muir, of Calcutta; the secretary, Dr. R. G. Cochrane, of London, and the treasurer, Dr. Brown, of the Bureau of Science, Manila. The temporary editors of the new journal on leprosy will be Dr. H. Windsor Wade, of Culion, the Philippines, as editor, and Dr. Lee, of Norway, and Dr. Maxwell, of China, as his assistants.

MR. STANLEY FIELD was reelected president of Field Museum of Natural History for the twenty-third time at the annual meeting of the board of trustees of the institution held on January 19. All the other officers who served during 1930 were also reelected for 1931. They are: Martin A. Ryerson, *first vice-president;* Albert A. Sprague, *second vice-president;* James Simpson, *third vice-president;* Stephen C. Simms, *director and secretary,* and Solomon A. Smith, *treasurer and assistant secretary.* The membership of the board now includes, in addition to these officers, the following: John Borden, William J. Chalmers, R. T. Crane, Jr., Marshall Field, Ernest R. Graham, Albert W. Harris, Samuel Insull, Jr., William V. Kelley, Cyrus H. McCormick, William H. Mitchell, Frederick H. Rawson, George A. Richardson, Fred W. Sargent, Silas H. Strawn and William Wrigley, Jr.

DR. MAZYCK P. RAVENEL, professor of preventive medicine and bacteriology at the University of Missouri, has been appointed consultant in public health and medical education to the Missouri State Board of Health.

DR. CALVIN H. KAUFFMAN, professor of botany and director of the University of Michigan Herbarium, retires with the title of professor emeritus of botany and director emeritus of the university herbarium, at the end of the academic year. He will be succeeded by Dr. Edwin B. Mains beginning with the second semester.

PROFESSOR WILLIAM M. GOLDSMITH has resigned his position as head of the department of biology of Southwestern College, Winfield, Kansas, to accept the position as professor of embryology and histology and lecturer in eugenics in the Municipal University of Wichita. Dr. Goldsmith was succeeded at Southwestern College by Dr. B. R. Coonfield.

DR. JOHN SHAW DUNN, professor of pathology in the University of Manchester, has been appointed to the chair of pathology in the University of Glasgow.

DR. WALDEMAR KAEMPFFERT, after having spent two and a half years in organizing the Museum of Science and Industry at Chicago, has handed in his resignation as director, to take effect on March 1. Mr. Kaempffert will become a member of the editorial council of the New York *Times* and will direct that paper's policy so far as science, engineering and industry are concerned. The work of designing and collecting exhibits for the museum will go forward uninterruptedly in accordance with the program originally formulated by Mr. Kaempffert and approved by the board of trustees. No successor has as yet been considered.

DR. D. S. VILLARS, assistant professor in physical chemistry at the University of Minnesota during the school year 1929–30, who later spent five months working in the research laboratory of the General Electric Company in Schenectady, has been appointed physical chemist in the research laboratory of the

Standard Oil Company of Indiana at Whiting, Indiana.

DR. MAJOR G. SEELIG, professor of clinical surgery in the Washington University School of Medicine, who retired from active practice last June, assumed the directorship on January 1 of a program of cancer research to be initiated at Barnard Free Skin and Cancer Hospital.

DR. C. C. YOUNG, director of laboratories of the Michigan Department of Health, has been appointed head of the department of preventive medicine at the Detroit College of Medicine and Surgery. He will continue in the same capacity in Lansing, having supervision of the work in Detroit.

DR. M. C. HALL, chief of the zoological division, Bureau of Animal Industry, has been designated president of the Permanent International Committee on Parasitology of the International Zoological Congress. This congress, which held its convention in Padua, Italy, in 1930, meets every four years to discuss subjects of international scope in the study of animal life. The committee is primarily concerned with the nomenclature of parasites.

MM. ROUX, Painlevé, Bouvier, Urban, Perrin, Grignard and Weiss and the permanent secretary have been appointed by the Paris Academy of Sciences members of the executive committee of the "Fondation nationale pour la découverte scientifique."

DR. A. J. GROUT will be at the Biological Laboratory at Cold Spring Harbor, Long Island, for six weeks each summer (in 1931, from July 31 to September 10) to take charge of such students and investigators as may wish to take up any problems connected with bryophytes: ecology, morphology, physiology or taxonomy.

DRS. DAVID H. KLING and Louis Nathan have been awarded fellowships of $2,400 each for 1931 by the committee of the Brown Orthopedic Research Fellowship of the Hospital for Joint Diseases; Dr. Kling won a scholarship last year. He will continue his researches on the fluids of joints; Dr. Nathan's research will deal with osteomyelitis and infantile paralysis.

DR. DAVID M. DENNISON, associate professor of physics at the University of Michigan, has leave of absence for the second half of the academic year to enable him to complete his work on the "Infra-red Band Spectra," undertaken at the request of the American Physical Society for publication in its quarterly journal, *Review of Modern Physics*.

DR. ROBERT P. MARSH, professor of biology at Gettysburg College, has been granted a sabbatical leave for the second college semester to be spent in travel and study in Europe. He will sail on January 30 for Italy and will return from Scotland in the fall.

DR. WOLFGANG PAULI, of the Technische Hochschule at Zurich, and Dr. Arnold Sommerfeld, of the University of Munich, were appointed to special lectureships in theoretical physics for the summer session of 1931 at the University of Michigan.

DR. ALBERT LA FLEUR, head of the department of science at Ball State Teachers College, Muncie, Indiana, has been invited to act as director of geography for a field trip organized by the department of geography in the University of Nebraska. The trip, which will start on July 18, is to continue for seven weeks. The itinerary includes Memphis, Chattanooga, Nashville, Washington, D. C., Boston, Baltimore, Philadelphia, New York, Quebec, Montreal, Toronto, Niagara, Detroit, Chicago, then back to Lincoln, Nebraska, the starting point. A region of special interest for study will be the lower St. Lawrence. The trip will include more than six thousand miles.

DR. C. H. MYERS, professor of plant breeding at Cornell University, left Ithaca on January 24 for China where he will serve as expert in the cooperative crop improvement project now in its fifth year. Other experts from Cornell University who have cooperated in this project are Professors H. H. Love and R. G. Wiggans.

ON January 8 and 9, Dr. E. M. East, professor of genetics at the Bussey Institution, Harvard University, lectured at the University of Michigan under the auspices of the Department of Zoology on "Heredity and Human Problems," "Possible Immunological Reactions in Plants" and "The Self-Sterility Problem."

PROFESSOR JAMES G. NEEDHAM, of Cornell University, lectured at the University of Michigan under the auspices of the Department of Zoology on January 19 and 20. A lecture on "War a Biological Phenomenon" was presented before a general audience. Two lectures of a technical nature, "May Flies" and "Transformations in Insects," were subsequently given.

DR. ROBERT H. GAULT, professor of psychology at Northwestern University, lectured at the University of Iowa on January 16 under the auspices of the Baconian Lecture Series on "Hearing through the Sense of Touch."

DR. OLIVER D. KELLOGG, of the department of mathematics of Harvard University, will open a course of lectures on February 9 as exchange professor at Knox College. Professor Proctor F. Sherwin, of the English department, will lecture at Harvard.

SIR WILLIAM B. HARDY, director of the Low Temperature Research Station of Biochemistry at the University of Cambridge, who will deliver the Abraham Flexner Lectures for 1931 in the Vanderbilt University School of Medicine, will arrive in Nashville to begin his work on February 15. Sir William will remain in residence at the School of Medicine for a period of two months, during which time he will lecture to the students and faculty of the School of Medicine, and will possibly deliver some public lectures. The Abraham Flexner Lectureship was established in the Vanderbilt University School of Medicine in 1927 by Dr. Bernard Flexner, of New York City. The lectureship brings in alternate years a scientific man of international reputation to the School of Medicine. Dr. Henrich Pohl, director of the Anatomical Institute of Hamburg, delivered the first lectures during the spring of 1928.

THE Galton Lecture, entitled "Warnings from Nature," will be given by Sir J. Arthur Thomson before the Eugenics Society, London, at the Galton Anniversary Dinner on February 16.

THE Hunterian Lecture was delivered before the Hunterian Society of London on January 19, by Dr. Arnold Lorand, of Carlsbad, on "The Problem of Rejuvenation."

THERE will be held in Rome, from June 3 to 7, an International Scientific Congress on Population in connection with the Second General Assembly of the International Union for the Scientific Investigation of Population Problems, this congress to be open to scientific papers by non-members as well as by members of the International Population Union. The congress will be divided into the following sections, for the reading of scientific papers, subject to possible changes as the plans develop: biology, demography, economics, anthropology, sociology, history, methodology.

THE eleventh summer session of the American School of Prehistoric Research will open in London on Wednesday, July 1, 1931, and close on the continent about September 8. The program includes lectures by the director and by foreign specialists, study of museum collections, excursions to important prehistoric monuments and sites, and actual experience in digging. Countries to be visited include southern England, France, Switzerland, Germany and Czechoslovakia. Students will have digging practice in a Paleolithic rock shelter (Dordogne) France. The last four weeks of the term will be devoted to digging in Neolithic and Metal-Age sites of Czechoslovakia; this part of the program will be in charge of Dr. V. J. Fewkes, of the University Museum, Philadelphia, assisted by Robert W. Ehrich, of Harvard University. Preference will be given to applicants who have a knowledge of French and German and who already have a bachelor's degree. Those who wish to enroll should apply immediately. Applications and requests for further information should be addressed to Dr. George Grant MacCurdy, Director, American School of Prehistoric Research, Peabody Museum, New Haven, Connecticut.

THE Eighth Congress of the Far Eastern Association of Tropical Medicine opened at Bangkok, Siam, on December 8. British India and the various provinces were represented by nine delegates, all Europeans. Japan, Formosa, Korea and Kwantung together sent seven; the Dutch East Indies five; the Straits Settlements, Federated Malay States, Hongkong and Indo-China three each; the Philippines two; other countries represented being Hawaii, British North Borneo and Macao. China was the only far eastern country not represented. The League of Nations was represented by Professor B. Nocht, and the Rockefeller Foundation by Dr. Victor G. Heiser. Some 177 medical men took part. The King of Siam sent a message of welcome and the congress was formally opened by the Minister of the Interior. The president elected for this congress was the King's physician (Prince Thavara), who in his address sketched the history of both old and modern medicine in this country.

DISCUSSION

THE VAMPIRE BAT

BLOOD-FEEDING bats in tropical America are mentioned by some of the earliest writers following the conquest of South America.[1] The exact species of these bats responsible for attacking man and other animals apparently remained unknown until Charles Darwin,[2] naturalist, on the memorable voyage of the *Beagle*, caught one in the act. He writes under the entry of April 9, 1832:

> The Vampire bat is often the cause of much trouble, by biting the horses on their withers. The injury is generally not so much owing to the loss of blood as to the inflammation which the pressure of the saddle afterwards produces. The whole circumstance has lately been doubted in England; I was therefore fortunate in being present when one (Desmodus d'orbignyi, Wat.) was actually caught on a horse's back. We were bivouacking late one evening near Coquimbo, in Chile, when my

[1] Flower and Lydekker, "Introduction to Study of Mammals, Living and Extinct," p. 676, 1891.

[2] "Journal of Researches into the Natural History and Geology of the Countries Visited during the Voyage of H.M.S. *Beagle* Round the World," p. 22, 1838.

servant, noticing that one of the horses was very restive, went to see what was the matter, and fancying he could distinguish something, suddenly put his hand on the beast's withers, and secured the vampire. In the morning the spot where the bite had been inflicted was easily distinguished from being slightly swollen and bloody. The third day afterward we rode the horse, without any ill effect.

Concerning the vampires, Flower and Lydekker write:

These Bats present, in the extraordinary differentiation of the manducatory and digestive apparatus, a departure from the type of other members of the family unparalleled in any of the other orders of Mammalia, standing apart from all other mammals as being fitted only for a diet of blood, and capable of sustaining life upon that alone. Travellers describe the wounds inflicted by the large sharp-edged incisors as similar to those caused by a razor when shaving: a portion of the skin being shaved off and a large number of severed capillary vessels thus exposed, from which a constant flow of blood is maintained. From this source the blood is drawn through the exceedingly narrow gullet—too narrow for anything solid to pass—into the intestine-like stomach whence it is probably gradually drawn off during the slow process of digestion, while the animal, sated with food, is hanging in a state of torpidity from the roof of a cave or the inner side of a hollow tree.

The sanguivorous nature of the vampires has thus long been known to mammalogists, but so far as I recall, these bats have never been referred to as among the parasites of man or other mammals. If many of the blood-sucking arthropods, such as the bedbug, are parasites, surely the vampires must be so classed.

The vampires range in distribution from Mexico, through Central America and throughout the warmer parts of South America. Several forms of them are known, being placed in three genera, *Desmodus Diphylla* and *Diaemus*, the last known only from Brazil and Guiana. Contrary to popular belief, these bats are of small size, the length of head and body being but about three inches. They are fairly common in many places and consequently must do considerable biting in order to exist.

No instance is recalled in which their attacks on human beings have resulted in more than trifling annoyances. Goldman[3] quotes Dr. Linnaeus Fussell, who had medical charge of a U. S. Government surveying party in eastern Panama in 1870 as follows:

The bites of vampire bats should be referred to, as the stories told of them are by many deemed rather apochryphal. We were troubled with them more or less during the whole time we were out, but ordinarily they did not prove a serious annoyance; toward the latter part of our trip, however, someone was bitten almost every night; one night, the 13th of May, nine men were bitten. The men were rarely awakened by the bites, which, however, bled freely, sufficient blood being usually lost to saturate the clothing and to show its effects very perceptibly in the loss of color and general feeling of weakness experienced.

The same manner of attack and the apparent lack of sensation in the act of biting is described by William Beebe.[4] He says of them:

For three nights they swept about us with hardly a whisper of wings, and accepted either toe, or elbow, or finger, or all three, and the cots and floor in the morning looked like an emergency hospital behind an active front. In spite of every attempt at keeping awake, we dropped off to sleep before the bats had begun, and did not waken until they left. We ascertained, however, that there was no truth in the belief that they hovered or kept fanning with their wings. Instead they settled on the person with an appreciable flop and then crawled to the desired spot.

Although the vampire bats must be regarded as among the free-living or temporary ectoparasites of man and other mammals, they can scarcely be regarded as more than curiosities in the field of human medicine. They are very much more easy to secure protection from than are mosquitoes and bedbugs. It has never been shown that they are carriers of any infection. In the field of animal husbandry they may at times be of more than passing interest.

MARCUS WARD LYON, JR.

SOUTH BEND, IND.

CONCERNING EARLY DIAGNOSIS OF WHOOPING COUGH

BEFORE diagnosis is attempted by the cough-plate method,[1] the beginner should master three important technical steps:

(1) The medium should be sterile, bright red and the surface should not be dry.

(2) A series of Petri dishes should be inoculated with B. pertussis and the small, discrete, round, elevated, shiny gray colonies should be studied from day to day. On the third to fifth day the colony approximates 1 mm in diameter and is surrounded by a zone which appears translucent in transmitted light and darkened in reflected light.

(3) Duplicate plates should then be exposed to early cases of known pertussis. Over-growth by mouth saprophytes can in part be avoided if the child drinks water just before the plates are exposed. An

[3] "Mammals of Panama," Smith. Misc. Coll., Vol. 69, p. 209, 1920.

[4] "Edge of the Jungle," p. 18, 1921.

[1] L. W. Sauer and L. Hambrecht, "Whooping Cough—Early Diagnosis by the Cough-Plate Method," *J. A. M. A.*, vol. 95, p. 263, July 26, 1930.

uncovered plate is held vertically, a few inches from the open mouth at the moment of expulsive coughs from the deeper bronchi. The plate should be incubated at 37° C. within a few hours, and be examined daily for four or five days. Rapidly growing saprophytes should be cut out with sterile platinum wire. The characteristic, zoned colonies usually appear on the third to fifth day. A hand lens used in bright light is helpful in finding the raised, circular colonies in thickly seeded plates. Poorly exposed plates should not be incubated. After mastery of the technic, aluminum boxes (4 cm × 1.5 cm) may be used. They require less medium, can conveniently be carried, and dry out more slowly (broad rubber band over seam).

Pertussis organisms are minute, oval, gram-negative bacilli which stain feebly. Polar staining may be present. If the cough has already persisted for several weeks, plates exposed to the other, susceptible children of the family will more likely be positive. A negative plate does not exclude pertussis, and a second plate may be positive. If the cough has persisted too long, or if it is not whooping cough, pertussis bacilli will not be found.

LOUIS W. SAUER

EVANSTON, ILLINOIS

THE FINDING OF LARGE CENTIPEDES IN WYOMING AND WESTERN NEBRASKA

ANY one acquainted with the Southwest is also more or less familiar with the wide-spread occurrence of centipedes, in sizes of two or three inches up to eight or more inches in length; and one of the items that has been considered an advantage to camping in the North is the absence of these pests. The writer has spent parts of every year for more than twenty-five years past in camp pretty well all over the region in question, and in contact with many others very familiar with such matters, and it has been a generally accepted belief that east of the Rockies in Colorado none of the centipedes of material size were ever to be found north of Colorado Springs and but very seldom north of Raton Pass along the New Mexico-Colorado border.

It was with astonishment, therefore, almost bordering on incredulity, that I heard Graham Bell Fairchild, student entomologist from Harvard University, casually mention killing about a four-inch centipede in camp about three miles south of Torrington, Wyoming, in the hills bordering the North Platte Valley, in the latter part of June, 1930. However, others were also killed here later this summer, and shortly after this members of the Country Club killed a four-inch centipede in the Country Club house at Scottsbluff, Nebraska, at a point about thirty miles east of the Torrington locality. These people thought it must have been a centipede brought in with fruit from the South in some fashion, but there would seem to be no chance of this being true at the Torrington locality. As local people who have lived all their lives in these sections and the surrounding region have never seen such centipedes before and as this is nearly five hundred miles north of the common range of such species the occurrence seems worthy of record. No attempt was made to identify the species, but the writer has requested that if others be found they be preserved in alcohol.[1]

HAROLD J. COOK

AGATE, NEBRASKA

THE EXCELSIOR GEYSER AGAIN

IN a letter from T. E. Hofer, Clinton, Washington, referring to my communication to SCIENCE, vol. lxviii, pages 644–645, I find the following testimonial to the vigor of Excelsior Geyser when it was active:

> Reading your Excelsior, Yellowstone Park notes, I was once crossing with a pack outfit about 200 yards below the geyser, when the darn thing exploded. We got all the animals safely across (on the geyser side), when the river rose about 10 inches, enough to have killed the whole outfit. The geyser threw out many rocks, some of them a foot square. I saw that geyser go off once after that. It was before a bridge was built.

EDWIN LINTON

ZOOLOGICAL LABORATORY,
UNIVERSITY OF PENNSYLVANIA

SPECIAL CORRESPONDENCE

THE ELLA SACHS PLOTZ FOUNDATION FOR THE ADVANCEMENT OF SCIENTIFIC INVESTIGATION

DURING the seventh year of the Ella Sachs Plotz Foundation for the Advancement of Scientific Investigation, seventy-eight applications for grants were received by the trustees, sixty-two of which came from twelve different countries in Europe and Asia, the remaining sixteen coming from the United States. The total number of grants made during this year was twenty-five, one of these being a continued annual grant. Twenty-one of the new grants were made to scientists in countries outside of the United States.

In the seven years of its existence, the foundation

[1] Since the above was written, several other reports have reached me of the finding of similar centipedes the past summer, including one in the gymnasium of the Chadron Normal College, at Chadron, Nebraska, reported to me by a student.—H. J. C.

has made one hundred and twenty grants and investigators have been aided in the United States, Great Britain, France, Germany, Austria, Hungary, Switzerland, Italy, Sweden, Esthonia, Czechoslovakia, Poland, Chile, Syria and Belgium.

The list of investigators and of the researches which have been aided in the current year is as follows:

Dr. George Barger, Edinburgh, $500 for chemical investigations of the alkaloids of ergot.

Professor Dr. Bohnenkamp, Würzburg, $500 for a new simple direct calorimeter.

Professor Dr. A. Bornstein, Hamburg, $400 for continuation of the study of the physiology and pathology of kidney function.

Professor Dr. M. Dennig, Heidelberg, $500 for continuation of work on rate of blood flow and breathing in sickness and in animals.

Dr. Emil Epstein, Vienna, $300 for investigations on Lipoid-Histocytosis.

Professor Carlo Foa, Milan, $500 for researches upon the normal and pathological metabolism of uric acid in dog and man.

Professor Otto Fürth, Vienna, $400 for study on the chemistry of proteins of the cell-nucleus, by Professor Otto Fürth and Theodore Leipert; and $400 for continuation of work on Urochrom-precursors in the urine and the blood serum by Professor Hermann Karl Barrenscheen.

Professor Paul Govaerts, Brussels, $500 for continuation of work on nephritis and edema.

Professor Paul Hari, Budapest, $500 for continuation of respiratory and metabolic experiments.

Professor J. P. Hoet, Louvain, $500 for investigation of insulin secretion and its physiological control.

Dr. Theodore Huzella, Debrecen, $400 for experimental investigations in different human and animal tumors.

Professor Dr. Erik Johannes Kraus, Prague, $150 for researches on the relationship of hypophysis and midbrain.

Professor Warfield T. Longcope, Johns Hopkins Hospital, $500 for studies on the experimental production of nephritis.

Professor Dr. Franz Lucksch, Prague, $300 for continuation of work on the tubercle bacilli.

Dr. David Marine, Montefiore Hospital, $500 for an attempt to separate the powerful goitrogenic agent present in cabbage.

Dr. E. B. McKinley, San Juan, $200 for continuation of work on experimental infection and immunity.

Professor Francesco Pentimalli, Rome, $250 for continuation of work on the nature of the agent of chicken sarcoma.

Dr. D. Scherf, Vienna, $250 for continuation of work on the "origin of extrasystoles."

Professor Dr. Carl Schlayer, Berlin, $250 for continuation of studies of the diuretic hormone contained in the brain.

Dr. E. A. Spiegel, Vienna, $400 for continuation of experiments on muscle tonus and on the central mechanism of epileptic fits.

Dr. A. Szent-Gyorgyi, Szeged, $500 for continuation of work on the chemistry and function of the adrenal cortex and biological oxidation.

Thorndike Memorial Laboratory, Boston City Hospital (Dr. George R. Minot, director), $500 in recognition of Dr. Peabody's services.

Professor Dr. Volhard, Frankfurt, $500 for continuation of studies on pathological kidneys.

Professor Dr. W. Weichardt, Wiesbaden, $250 for continuation of investigations on non-specific therapy.

Professor Edgard Zunz, Brussels, $500 for continuation of studies of pancreatic secretion.

In their first statement regarding the purposes for which the fund would be used the trustees expressed themselves as follows:

(1) For the present, researches will be favored that are directed towards the solution of problems in medicine and surgery or in branches of science bearing on medicine and surgery.

(2) As a rule, preference will be given to researches on a single problem or on closely allied problems; it is hoped that investigators in this and in other countries may be found, whose work on similar or related problems may be assisted so that more rapid progress may be made possible.

(3) Grants may be used for the purchase of apparatus and supplies that are needed for special investigations, and for the payment of unusual expenses incident to such investigations, including technical assistance, but not for providing apparatus or materials which are ordinarily a part of laboratory equipment. Stipends for the support of investigators will be granted only under exceptional circumstances.

In accordance with the policy outlined in paragraph 2, four of the investigations which have been aided in 1930 bear on the general subject of nephritis; in 1929 there were seven, in 1928 three, and in each of the four preceding years four grants for work in this same field. Other general subjects, especially internal secretion and infection, have been favored by grants in successive years, but not to so great a degree as nephritis.

Applications for grants to be held during the year 1930–1931 should be in the hands of the executive committee before May 1.

Applications should include statements as to the character of the proposed research, the amount of money requested, and the objects for which the money is to be expended.

Applications should be sent to the secretary, Collis P. Huntington Memorial Hospital, 695 Huntington Avenue, Boston, Massachusetts.

JOSEPH C. AUB,
Secretary

QUOTATIONS

ELLWOOD HENDRICK

A FRIEND can not be defined. He is never made: he comes, when and how who shall say? Only where the wind listeth. He can not be a woman: subtle, homosexual harmonies tie the relationship. He is the greatest and rarest of discoveries: the inestimable loss. The intensity of friendship may vary greatly: waiting as it does upon opportunity for its upgrowth, ripening with time, its character is of instant determination: at least, you know at once who are the people you will like.

Ellwood Hendrick, almost by his name, made instant appeal to me ten years or so ago when we met at one of our summer chemical gatherings. To write the common, catalogued, laudatory notice of such a man is impossible, the more as he has no base professional claim. When with him I had the feeling that "Rip van Winkle" was at hand, having Jefferson's inspired presentation of the delinquent in mind —a vision unfortunately impossible to the modern generation. Hendrick was a bit of a Rip and both in build and manner of Dutch complexion, with sufficient *Diable au corps,* I believe of Irish origin, to make him artist and humorist as well—no mere testubical chemist. Giving avuncular advice on the study of chemistry, he could slyly write—

> You'd better join the Church before
> This course is well begun,
> Because you'll need to exercise
> The art of faith, my son.
>
> I used to think theology
> Was rather rough on doubt
> But chemistry with ions beats
> Theology all out.

Long an admirer of Lafcadio Hearn—the strangest of hybrids, Greek-Irish by descent—in reading his "Life and Letters," by Elizabeth Bisland (1906), I had wondered what manner of man the Ellwood Hendrick could be to whom Hearn had addressed such wonderful outpourings, even calling him "Dear, Devilishly Delightful, Old Fellow" (in 1891). Hearn wrote his friend's epitaph in using these words. This is what I at once found him to be. We exchanged letters freely and it took me but a short time to fathom the secret of Hearn's love of the man. The full story of this friendship was given by Hendrick, in an essay he contributed to the *Bulletin* of the New York Public Library last year; he had presented the precious originals of the Bisland letters to the library in 1919.

Hendrick tells how he first met Lafcadio Hearn, in 1888, in New York, at a select gathering of literary people, including Elizabeth Bisland—the most beautiful woman he ever saw. Hearn was then on his return from two years in the French West Indies; this was a year before he went to Japan. Quickly seeing how utterly miserable Hearn was in the presence of strangers, owing to his intense shyness, accentuated by his partial blindness, Hendrick soon took him away—as an old Heidelberg Corps student should, naturally to "a none too respectable beer cellar," the only possible place of resort in the circumstances. The beer fulfilled its divine appointed purpose. They talked of many things. In the end Hendrick resolved that here was his opportunity:

> . . . that if this man would only let me, I would cultivate his friendship and be with him as much as I might, for it seemed as though, through him, a light was dawning on my horizon.
>
> Perhaps I had better explain a little about myself. I had studied chemistry abroad and had planned to organize a great synthetic organic chemical industry in the United States. It had started and proceeded for three years until we finally produced excellent materials. But our sales organization was defective, tariff changes and a bad year ensued; there arose disagreement among the proprietors, the bonds foreclosed and that was an end to it all for me. I was young and foolish and resolved to have nothing more to do with chemistry which had been, I felt, a false mistress to me. The dreams of my boyhood and young manhood were shattered, I believed my future to have been destroyed, that nothing but commonplace things would be available to me and that the whole business of living was hardly worth while. It was easy enough to make a living by sticking to my job but even if it did lead to a better post and more pay it lacked the distinction on which I had set my heart—and been disappointed. In short, my ambition was hardly to be recognized.
>
> I did not tell these things to Lafcadio as I have told them here but he sensed the situation. And just as I resolved that night to cling to this man in the hope of enlightenment, I believe he resolved to fan the almost extinct spark of ambition in his new companion, who was ten years his junior, until it might burn again and warm his disappointed soul.

Ellwood Hendrick was born at Albany, N. Y., on December 19, 1861; he died in his New York home on October 29, 1930. Educated for the most part abroad, at twenty he became manager of the Albany Aniline Dye Works—it is not surprising that he was unsuccessful. He then spent over thirty years in insurance work. He returned to chemical work, in 1917, with the Arthur D. Little Co., Cambridge, Mas-

sachusetts. In 1924, he was appointed curator of the Chandler Museum in Columbia University. Of late, he exercised a great influence upon the social development of Columbia students, seeking to make them men of the world. All sorts of willing helpers came to his aid—distinguished actresses and others. He had a very pretty pen, as all know who have his delightful volume of "Percolator Papers" (Harper Bros., 1919), a model in its way—named after the organ of the New York Chemists' Club. He could write on subjects so far apart as Saul of Tarsus and C_2H_5OH—even ascribe to the latter the greater influence for good in the world.

Hendrick was a perfect letter writer. Early in March of last year, he wrote me a rapturous account of "Green Pastures," the work of his friend Marc Connelly. "I'm so full of it, I want to write about it to some sympathetic soul." To him it was a wonderful picture of the way in which the "darkies" took the Bible and adjusted it to their own minds. (This may not be without repercussion upon ourselves, if we consider what is the effect upon students of textbook tarradiddles and modern pseudo-scientific mysticism.) "It is all real from a simple and childish point of view that everybody had once. I urge you to see it. It is free from all the offensiveness of apologetics." His charm, in fact, lay in his being himself a primitive. In "Green Pastures," Hendrick was in the element native to his spirit.—HENRY E. ARMSTRONG in *Nature*.

SCIENTIFIC BOOKS

The Migration of Butterflies. By C. B. WILLIAMS. Biological Monographs and Manuals, No. IX; Edinburgh and London: Oliver and Boyd, 1930, pp. xi + 473, 71 figs. (all diagrams and maps).

MR. WILLIAMS has been studying the subject of migration for a number of years and has written much about it. He has paid especial attention to the migration of butterflies. His successive residences in England, United States, British West Indies, Egypt and East Africa have given him unusual opportunities for observations, and he has not only made the most of these opportunities but has corresponded largely with naturalists in different parts of the world and has collected the literature of the subject very carefully.

The present volume is painstaking and full. The actual evidence in regard to each species is displayed with great care and detail in the first 312 pages. Part IV of the book, which gives a general discussion, is both interesting and important. It contains chapters on the true nature of migratory flights, on the condition and the behavior of the migrants, the conditions determining the start of the flight, and the determination of route and goal. Then follows a chapter on comparison with other animals, in which dragon-flies, locusts and other insects, birds, mammals and fishes are considered. And then there is added a chapter on general problems, with another which contains a summary, conclusions and suggestions for further work. The bibliography is extensive and covers 26 pages of fine type. The format of the book is admirable. Other monographs in this series are probably well known to workers. The general editors, as is well known, are F. A. E. Crew, of Edinburgh, and D. Ward Cutler, of Rothamsted. The object of the series is an admirable one, namely to provide authoritative accounts of what has been done in some of the diverse branches of biological investigation and at the same time to give those who have contributed notably to the development of a particular field of inquiry the opportunity of presenting the results of their researches, scattered through the scientific journals, in a more extended form, showing their relation to what has already been done and to the problems that remain to be solved.

As Mr. Williams states in his introduction, he has not included in his book any entirely new records of migration not published elsewhere. The work, however, brings the subject quite down to date, and it is done in a masterly way by a broad and very competent student.

L. O. HOWARD

BUREAU OF ENTOMOLOGY

Barlow's Tables of Squares, Cubes, Square Roots, Cube Roots and Reciprocals of all Integer Numbers up to 10,000. Third edition. Revised and enlarged by DR. L. J. COMRIE. Pp. xii, 208. E. and F. N. Spon, London, 1930.

PETER BARLOW'S TABLES will need no introduction to many of the scientists who have found it desirable to use a calculating machine in their work. These tables originally appeared in 1814; a new incomplete edition was edited by Augustus de Morgan in 1840. Since then, an ever-increasing demand for the book has led to many printings from the stereotype plates of 1840.

It is very fortunate that the present revision of these tables has been carried out by Dr. Comrie. His expert knowledge of the efficient use of calculating

machines and his wide experience in the construction of tables fitted him well for the task.

It will not be necessary to go into great detail regarding the content of this book since the title gives a very good idea of the principal tables. The present edition retains all the valuable features of the first two editions, and in addition contains certain new tables. Among the latter may be mentioned factorial n up to $n=100$, and n^4 and $1/\sqrt{n}$ up to 1,000. For the integers between 1,000 and 10,000, inclusive, $\sqrt{10n}$ is given in addition to the usual $\sqrt{n}$. The powers up to the tenth of the first hundred integers and powers up to the twentieth of the first ten integers are given.

Interpolation in the tables of square roots, cube roots and reciprocals is facilitated by the provision of interlinear first differences. The square roots and cube roots have been cut to eight significant figures, a number sufficient for practically all purposes. The computer will appreciate the fact that the publishers have chosen to use clear, easily-read modern type and a good grade of paper.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A CONVENIENT HYDROMETER FOR DETERMINING THE SPECIFIC GRAVITY OF HEAVY LIQUIDS

THE separation of minerals from loose aggregates by using liquids of high specific gravity is a common practice in the study of a variety of sedimentary rocks. Frequently only one cut is made of the aggregate, the desire being to separate the heavy minerals, or those with a specific gravity of about 2.8 and above, from the more common quartz. In such a case bromoform that will float quartz is satisfactory, and the quickest test of density is to drop a grain of quartz in the liquid. In other cases it may be desirable to make cuts between the quartz and some of the feldspars, and then the extreme heavies; or between the quartz and the carbonates; or many other cuts at a variety of values of specific gravity. In such cases it is necessary to know the exact specific gravity of the liquid used, and to control the dilution when preparing a liquid for a specific separation.

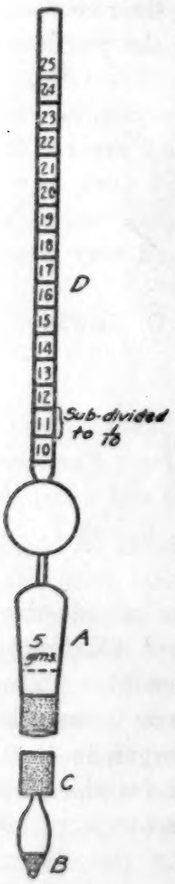

FIG. 1

Various methods have been used by the writer in making specific gravity determinations of heavy liquids. A small picnometer has been used with good success, but the method is tedious and time-consuming. Eimer and Amend, of New York, on the suggestion of the writer, recently prepared a new type hydrometer with which the specific gravity of a liquid between 2.000 and 5.000 can be determined accurately and quickly in one operation. A distinct advantage of the apparatus is that only 5 cc of the liquid is needed for a test. When mixing liquids in small quantities to obtain a required specific gravity, quick determinations are possible with this instrument.

The hydrometer is made of glass tubing with a ball float near one end and just above a liquid chamber *A*. Fig. 1 shows the hydrometer in the inverted position as it is placed in a column of water and the scale is read. A small amount of mercury *B* is used as a balancer, and is sealed in the glass stopper *C* which fits in the liquid chamber. A scale *D* with graduations from ten to twenty-five grams, sub-divided in tenths, is contained in the long glass rod. The liquid chamber or cylindrical bulb is marked to show the level of five grams of distilled water at 20° C. The glass stopper is ground for tight fitting when the hydrometer is inverted in a cylinder of water.

To determine the specific gravity of a liquid which is between 2.000 and 5.000, the liquid chamber *A* is filled with the liquid to the level marked on the bulb, the stopper put in place securely, and then the whole is inverted and floated in distilled water in a tall cylinder. A 1,000-cc cylinder of six or seven cm diameter is satisfactory. The bottom of the meniscus of the water is read on the graduated scale of the long glass tube and this value divided by five (the gram units of the water capacity of the bulb) gives the specific gravity of the liquid.

The instrument may be used for the determination of gravities of solid particles as well, the usual weighing in air and weighing in water being necessary, the balance being the float of the hydrometer in the water. Only two operations and measurements are necessary. (1) Place the solid mineral or rock particle (air dry) in the specimen bulb (which is the liquid chamber *A*), insert stopper and float in the column of water. The value read is the weight of the specimen in air. (2) Put distilled water in the specimen chamber up to the 5 cc mark, and again make a reading with the instrument floating in the column of water. This value is the weight of the

specimen in water. Since the weight of the water displaced by the solid particle is the equivalent of the buoyant force on the solid body, and the known capacity of the specimen chamber is five grams of distilled water, the amount of water displaced, or the loss of weight of the specimen weighed in water, is readily determined and the specific gravity of the particle calculated. An example of the calculations is given below:

Weight of dry specimen in chamber	14.3 gm
Weight of full chamber of water	5.0
Total, specimen alone, and water alone	19.3 gm
Weight of specimen in water to the 5 gm marks on bulb	15.6 gm
Amount of water displaced	3.7 gm

$$\text{Specific gravity} = \frac{14.3}{3.7} = 3.86$$

The size of the hydrometer may be a hindrance to some workers. If such is the case, a model one half the length and volume may be used, but for the same range of specific gravity the results will be less accurate.

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REPAIR OF NON-CONDUCTIVE GALVANOMETER STRINGS[1]

THE gilded quartz fibers used in the string galvanometer sometimes lose conductivity without actually breaking. Such fibers may generally be repaired without removing them from the galvanometer. The break in the metallic coating may be located by the use of a single dry cell and a pair of high-resistance head phones. The negative pole of the battery is connected to a string terminal, and under a bright light the string is gently touched at increasing distances from this terminal with a light copper wire connected to the other pole of the battery through the head phones. When the point is reached where a click is no longer heard in the phones, the battery is connected to the opposite string terminal and the process is repeated from the other end to ascertain if the break is confined to one point.

The break in the metallic coating having been located, both string terminals are connected. The repair is then easily made by wetting the positive copper wire with copper sulphate solution and touching the string at the break. Electrolytic deposition of copper will usually restore the conductivity of the string.

Should the break occur exactly under the lenses of the galvanometer microscopes, the slightly roughened string surface where the repair was made may be displaced upward or downward by shifting the entire string by means of a string holder. Ordinarily the repaired strings are not appreciably changed from their original resistance.

CHESTER W. DARROW

[1] Report from the Behavior Research Fund, Chicago: Series B, No. 170.

A SIPHON MOIST CHAMBER FOR MICROSCOPIC MOUNTS

FOR several years the writer has used a method for keeping a water mount continuously supplied with water. The arrangement is so simple that it seems probable that it has been previously used and described and, although the method is original with the writer, no claim of priority is made since it has not seemed worth while to make a canvass of literature. The present note is given to recommend its more general use.

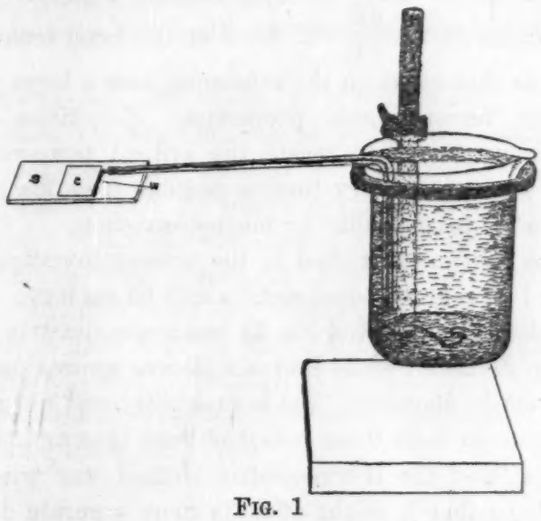

FIG. 1

A glass tube about 25 mm, or less, with a bore of about 4 mm, is bent at right angles about 8 mm from one end. With the aid of a wire, a cord having the texture of candle wick is pulled through the tube leaving about 1½ mm of the cord extending beyond the long arm and several millimeters beyond the short arm of the tube. The cord is thoroughly wet and the end of the short arm with projecting wick is immersed in a beaker of water. The beaker is suspended in a metal ring which is attached to a ring stand so that the beaker may be raised or lowered. The long arm of the tube is supported by the rim of the beaker and its end rests on the slide (s), close to the edge of the cover-glass (c), which is preferably square. The short end of the wick (w) is pressed against one side of the cover-glass. The beaker can be so adjusted that a perfect balance of the flow of water through the wick and evaporation of water from the mount can be maintained so that water is under the entire cover-glass and none extends beyond its edge. If the beaker is elevated too high the slide will become flooded, and if too low the mount will become

dry. A mount can be made in a nutritive solution and with this method the concentration will not be changed. The tube and beaker of water can be sterilized so that the mount will keep in good condition for several days though the length of time will depend on whether it has been made from pure culture or fresh material. If the tube is properly elevated there will be no water current so that this method is also favorable for photomicrographic work.

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SPECIAL ARTICLES

SOME PECULIARITIES IN THE THERMOELECTRIC PROPERTIES OF MONEL METAL

IT has been shown by Tait[1] and by Belloc[2] that there is a very close relationship between the magnetic and the thermoelectric properties of certain ferromagnetic substances. For iron and nickel there is a maximum in the $\frac{dE}{dT} - T$ curve at the same temperature as that at which the substance loses a large part of its ferromagnetic properties. Sometimes this maximum serves to locate the critical temperature with greater accuracy than is possible from measurements on permeability or magnetostriction.

The specimens studied in the present investigation were two rods of monel metal about 60 cm long. The one designated as Rod No. 31 was approximately 0.65 cm in diameter, while Rod No. 32 was approximately 0.48 cm in diameter. The permeability and magnetostriction in both these rods had been investigated by others[3] and the thermoelectric method was tried in the hope that it might afford a more accurate determination of the critical point.

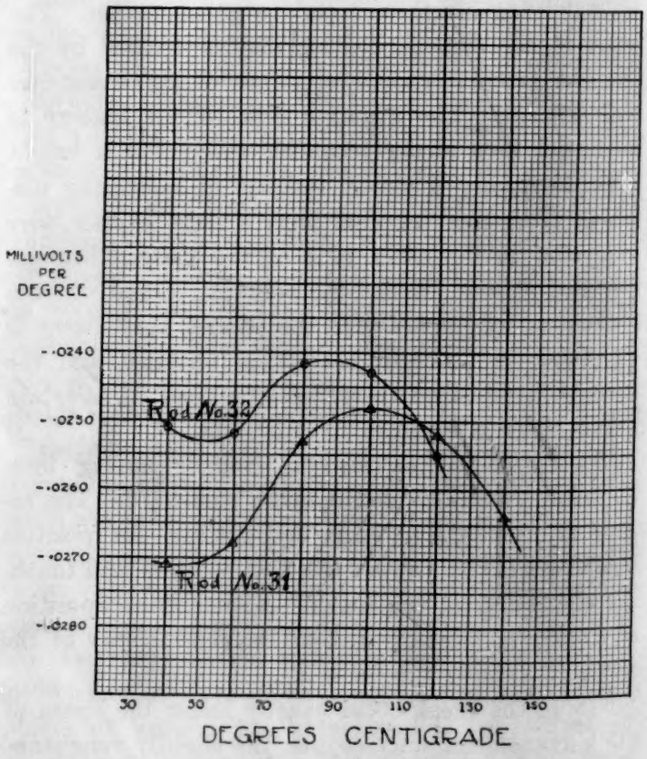
Each rod was joined at one end to a suitable length of lead wire to form a lead-monel metal thermocouple. The couple under test, together with a chromel-alumel couple, was mounted so that the "hot junctions" could be heated in an electrically heated oil bath while the "cold junctions" were maintained at 0° C. in a suitable ice bath. The leads from the cold junctions were connected to a potentiometer through a double-pole, double-throw switch so that readings of the e. m. f. for the two couples could be taken alternately at short intervals. The temperature of the oil bath was raised at the rate of about 2 to 2.5° C. per minute and the e. m. f. of each thermocouple was read every minute. With this rate of heating, the temperature can be considered as a linear function of the time for short periods and, hence, the temperature of the lead-monel metal couple at the time that its e. m. f. was observed was obtained by interpolation from the readings on the chromel-alumel couple.

[1] P. G. Tait, *Proc. Roy. Soc. Edin.* 7, 597, 1871.
[2] G. Belloc, *Ann. de chim. et de phys.* 30, 42, 1903.
[3] D. R. Inglis, *Instruments*, 2, 129–132, 1929.

In the following table the average values $\frac{dE}{dT}$ are given as computed from these data for intervals of $dT = 20°$ C. The use of smaller intervals for dT, although desirable, did not seem to be warranted by the accuracy of the data and method.

Interval	Mean temperature, T° C.	$\frac{dE}{dT}$ in millivolts per degree	
		Rod No. 31	Rod No. 32
30– 50°	40°	−0.0271	−0.0251
50– 70°	60°	−0.0267	−0.0252
70– 90°	80°	−0.0253	−0.0242
90–110°	100°	−0.0248	−0.0243
110–130°	120°	−0.0252	−0.0255
130–150°	140°	−0.0264	

When these results are plotted, as in the accompanying figure, the maxima are quite definite, at



100° C. for Rod No. 31 and at 87° C. for Rod No. 32. The number of observations made does not justify claiming an accuracy of better than 2 or 3 degrees

for these points, so that the results are to be regarded as qualitative rather than quantitative. It should be noted that Rod No. 31 exhibits a greater change than Rod No. 32. This is in agreement with previous observations[4] on the permeability and magnetostriction of these rods which showed that Rod No. 31 is more ferromagnetic than Rod No. 32.

The author is very much indebted to Professor S. R. Williams for suggesting the problem and to Professor W. W. Stifler for valuable advice and assistance in carrying out the experimental work and in preparing the results for publication.

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STROPHANTHIN. XIX. THE DEHYDROGENATION OF STROPHANTHIDIN AND GITOXIGENIN

IN the course of our investigation of the structure of the cardiac aglucones a number of these substances have been submitted to the action of dehydrogenating agents with the hope of obtaining reaction products which would point to the structure of the fundamental hydrocarbon skeletons upon which these aglucones are built. Following preliminary inconclusive experiments with platinum black and sulfur, the use of the selenium method of Diels, Gädke and Körding[1] has been employed and has given results of a more promising character. The preliminary observations with strophanthidin and gitoxigenin are as follows.

STROPHANTHIDIN

A mixture of 45 gm of strophanthidin and 65 gm of selenium was heated in an atmosphere of nitrogen for 45 hours at 330–340°. The chloroform extract of the reaction mass yielded a thick oil. A preliminary distillation of this material at 2 mm gave 12.3 gm of semi-crystalline substance which when refractionated at 2 mm gave the following hydrocarbon fractions.

Fraction I. −190°. 1.9 gm of a thick yellow oil which crystallized only partially on standing.

Fraction II. 190–210°. 3.9 gm of partly crystalline material.

Fraction III. 210–230°. 1.9 gm mostly crystalline.

Fraction IV. 230–250°. 1.6 gm mostly crystalline.

Fraction I gave a picrate in alcoholic solution which after recrystallization from an alcoholic picric acid solution was reconverted into the hydrocarbon. This separated at first from alcohol as shining plates which melted at 112–115°. After four recrystallizations from alcohol the melting point was raised to 130–134°. Analysis gave C 92.99, 93.26; H 6.55, 6.88. Calculated for $C_{18}H_{16}$: C 93.05, H 6.95.

The molecular weight determined in camphor gave 228, 212. Calculated for $C_{18}H_{16}$: 232.

Fraction II, after pressing off the oil, gave plates from alcohol which at first melted at 180–195°. After successive recrystallizations from alcohol, acetic anhydride and benzene it melted at 230–237°.

Analysis gave C 93.29, 93.34; H 6.09, 5.92.

Fraction III, after pressing off adhering oil and recrystallizing from alcohol, first melted at 195–210°. After repeated recrystallizations from acetic anhydride, benzene and finally thiophene it melted at 240–245°.

Analysis gave C 93.64, 93.41; H 6.29, 6.25.

Fraction IV was obtained as plates from alcohol. After repeated recrystallization from acetic anhydride, alcohol and thiophene a faintly yellow substance was obtained, which melted at 285–292°. This hydrocarbon was practically insoluble in alcohol, ether, petroleum ether and acetone.

Analysis gave C 93.66, 94.00; H 5.71, 6.04. Calculated for $C_{23}H_{18}$: C 93.83, H 6.17.

The molecular weight determination gave 310, 315. Calculated for $C_{23}H_{18}$, 294.

GITOXIGENIN

When gitoxigenin was dehydrogenated with selenium about 20 per cent. of its weight of hydrocarbon was recovered. This was separated roughly into two fractions. The lower fraction was an oil which slowly and incompletely crystallized. This was converted first into a picrate which after recrystallization was reconverted into the hydrocarbon. After two recrystallizations from alcohol, platelets were obtained which melted at 135–150°.

Analysis gave C 92.80, H 6.45.

Fraction II was partly crystalline. The oil was pressed off. Recrystallization from alcohol gave platelets which melted at 195–210°. After several recrystallizations from acetic anhydride it melted at 223–230° and resembled closely in solubility and crystalline form the so-called $C_{23}H_{18}$ hydrocarbon obtained from strophanthidin.

Analysis gave C 93.70, 93.86; H 6.25, 6.06.

Owing to the great difficulties attending the isolation of homogeneous individuals from mixtures of hydrocarbons, especially where the amounts available are so limited, the observations here given may be

[4] S. R. Williams, *Phys. Rev.* 29, 370, 1927, and D. R. Inglis, *loc. cit.*

[1] O. Diels, W. Gädke and P. Körding, *Ann. d. Chem.*, 1927, *459*, 1.

regarded only as preliminary and can only suggest the general nature and probable molecular size of these substances. Further work is in progress, the results of which will be described in detail elsewhere.

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ELMER E. FLECK

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THE FAUNA OF THE MIDDLE DEVONIAN BEAUVAIS SANDSTONE OF MISSOURI

THE complexly faulted Little Saline Creek area of Ste. Genevieve County, Missouri, has been the site of one of the University of Chicago's geological field camps for nearly twenty summers. During the course of detailed field mapping students and instructors alike have, from year to year, continued to find new structural and paleontological features, many of which have proved to be of more than local interest. One of the early discoveries was the fact that a brown, sugary sandstone, which had been called the St. Peter by some geologists, was in reality very much younger than that formation. This sandstone, which proved to be only one of a complete sequence of lower and middle Devonian formations preserved in a down-faulted block, was early designated by Weller as the Beauvais formation. His detailed description of the sandstone, however, did not appear until posthumously in 1928.[1]

The stratigraphic position of this sandstone between the Onondagan Grand Tower limestone and the Hamilton St. Laurent formation having been determined, its mid-Devonian age was established. Its exact correlation with other deposits of somewhat similar age, however, has been difficult because of its essential lack of well-preserved organic remains. According to Weller, fossils are rare in the formation and have been observed only at an outcrop on the Little Saline Creek near the Boarman School road. At this locality a number of species of invertebrates are represented by poorly preserved internal casts. The only species which is at all common is one identified as *Newberrya claypolei;* the condition of the others does not permit their identification. Branson and Williams,[2] however, five years earlier listed the following species from the Beauvais sandstone:

Atrypa reticularis (Linnaeus)
Chonetes vicinus (Castelnau)
Schizophoria striatula (Schlotheim)
Spirifer granulosus (Conrad)
Stropheodonta demissa (Conrad)
Tentaculites sp.

No locality is given for these species, but as Branson and Williams say that the specimens studied "were collected" and "most of the species were identified by Professor Weller's students before they were sent to the writers . . ." we may assume that they came from the locality mentioned above, and that Professor Weller felt that the identifications were none too certain.

One of the interesting discoveries of the field season of 1930 was the fact that the Beauvais sandstone is fossiliferous at other localities than that previously mentioned. One of these borders the old road on the south side of Peach Tree Ridge almost directly north of the Boarman School; a second is situated along the southern side of the triangular fault block of Beauvais near the top of the above-mentioned ridge, and the third occurs near the northern apex of the easternmost Beauvais fault block on Troublesome Hill, not far west of the Ozora-St. Mary's road. All three of these localities are at or near fault lines where the sandstone, as a consequence, is somewhat better cemented than usual. As a further result the fossils are more readily identifiable than is the case of those taken from Weller's locality, though it must be admitted that the preservation is not very good. A study of the material from these localities makes it possible to list the following assemblage as the known Beauvais fauna:

Favosites (several species)
Crinoid stems
Bryozoan (dichotomous branching)
Orbiculoides lodiensis var. *media?* (Hall)
Crania crenistriata Hall
Stropheodonta demissa Conrad
Leptaena rhomboidalis (Wilckens)
Chonetes vicinus (Castelnau)
Camarotoechia sp.
Cyrtina sp.
Schizophoria striatula (Schlotheim)
Atrypa reticularis (Linnaeus)
Athyris fultonensis Swallow
Spirifer granulosus (Conrad)
" *pennatus* (Atwater)
" *varicosus* Hall
" sp.
" n. sp.
Nucula sp. 1
" sp. 2
Nuculites oblongatus Conrad
Palaeoneilo maxima (Conrad)
Pterinea flabellum (Conrad)
Actinopteria boydi Hall
Leiopteria cf. *gabbi* Hall
Modiomorpha sp. 1
" sp. 2

[1] Missouri Bureau of Mines and Geology, 22 (1928): 148–50.

[2] E. B. Branson and J. S. Williams, Missouri Bureau of Mines and Geology, 17 (1923): 131.

Paracyclas elliptica Hall
Platyceras cf. *reflexum* Hall
Tentaculites bellulus Hall
Nephriticeras (unnamed species found in Grand Tower)
Bactrites? aciculum? Hall
Proetus crassimarginatus Hall
" cf. *haldemani* Hall
Phacops cf. *cristata* Hall
Ostracodes (several species)
Onychodus sigmoides Newberry

No apology is made for the lack of specific identification in some instances and the indicated uncertainty in others, nor is the faunal list considered complete. The identification of most of the species given, however, is thought to be correct in spite of the imperfect preservation of much of the material upon which determinations were based.

Of the twenty-three forms specifically identified or referred to species, twelve are also found in the Grand Tower fauna, five are known from the St. Laurent, one is found in the Onondaga division of the Romney of Maryland, two in the Hamilton division of the Romney, and three in the Hamilton of New York. The paleontologic evidence, therefore, indicates a fauna transitional between the Grand Tower and the St. Laurent. In other words, the Beauvais fauna shows both Onondagan and Hamilton affinities. Thus the formation is doubly unique in that it has neither exact lithologic nor paleontologic equivalents in the Devonian of the North American interior, although its stratigraphic position is similar to that of the Marcellus shale of New York. The intermediate character of the fauna may be taken as proof of the fact that the Beauvais sandstone is essentially conformable with the enclosing formations, although the actual contacts have not been seen. The lithologic evidence also supports this conclusion, for the upper Grand Tower limestone contains sand grains of the Beauvais type in increasing amount upward, and the lower St. Laurent beds are also more arenaceous than the higher strata.

Because of the distinctly intermediate character of the fauna and the intricacies of the fault patterns, a natural question is: has the fauna described an intermediate aspect because of the fact that some of the material collected was actually taken from the more arenaceous phase of the Grand Tower and mixed with other material from the lower St. Laurent? The answer is that such a mixture is most improbable for (1) no St. Laurent has ever been identified near any of the three localities here described; (2) the matrix is in each locality entirely non-calcareous, which is not the case of either the arenaceous Grand Tower or St. Laurent, and (3) almost all the species listed above may be collected from a single large block of the sandstone at the locality near the top of Peach Tree Ridge.

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RESPONSES OF SHEEP TO ZYGADENUS GRAMINEUS, "DEATH CAMAS"

MORE than a quarter of a century ago the symptoms produced in sheep after eating *Zygadenus gramineus* or "death camas," one of the most noxious plants growing upon the ranges of Colorado, Montana and Wyoming, were observed and recorded by Chestnut and Wilcox,[1] and quite similar responses were noted by Marsh and Clawson[2] during the forced feeding experiments conducted by them. Laboratory studies were made upon the alkaloidal principles of this plant and the reactions produced in laboratory animals following their administration by Reid Hunt,[3] Torald Sollmann[4] and by Mitchell and Smith.[5]

The annual loss of great numbers of sheep after having eaten of this plant has prompted a further study of the action of the active principles of this plant upon these animals in order to secure all data possible respecting the point and mode of action of these principles.

A fluid extract made from the dried herbage of this plant was dried upon spent marc and extracted with petroleum and ethyl ethers in order to remove resins present in the original extract. The remainder of the extract was percolated with 90 per cent. alcohol, which later was evaporated by means of gentle heat, and the semisolid residue was taken up in dilute alcohol and filtered. This filtrate, which was employed for intravenous injections, contained 0.004 gram of alkaloids per cubic centimeter in a solution of 21 per cent. alcohol.

The four sheep employed for these experiments were anesthetized with ether followed by a solution of amytal given intravenously. It was found necessary to supplement the dosage generally used for laboratory animals with a 20 per cent. solution of urethane in Locke's solution given intravenously or by chloretone in oil injected intraperitoneally. Chloretone in oil alone was unsatisfactory. The intravenous injections were made by way of one of the

[1] Chestnut and Wilcox, Bulletin No. 26, Division of Botany, U. S. Dept. of Agriculture, pp. 51–64, 1901.
[2] Marsh and Clawson, Bulletin No. 125, Professional Papers, U. S. Dept. of Agriculture, 1915.
[3] Reid Hunt, *Am. Jour. Physiol.*, 6: xix–xx, 1902.
[4] Torald Sollmann, see Marsh and Clawson, p. 3.
[5] Mitchell and Smith, *Am. Jour. Physiol.*, 28: 318, 1911.

veins located on the lateral aspect of the tibio-tarsal or hock joint.

After complete immobility was secured, these sheep were connected with the instruments generally used for making graphic records of circulatory and respiratory movements. Sheep of from 55 to 69 pounds weight recovered spontaneously after the intravenous injection of 0.4 to 0.8 cc of the extract despite the inhibition of respiration lasting from one to several seconds.

Almost immediately after the injection of one cubic centimeter of the extract there occurred an apnoea of 20 seconds followed in turn by a few irregular, shallow respiratory movements and another period of apnoea which was accompanied by an elevation of 50 mm in blood-pressure. This rise of blood-pressure was brought back to normal after a short period, 10 to 12 seconds, of artificial respiration only to be followed two minutes later by another period of apnoea enduring for a full minute. Altogether there occurred four asphyxia-like rises of blood-pressure, varying from 44 to 108 mm of Hg above the previous normal, whose inceptions were preceded by apnoea enduring from one third to one minute before the animal recovered. These asphyxia-like rises of blood-pressure were always reduced to normal by means of artificial respiration, following which, except in the fourth case, there occurred irregular respiratory movements, displaced in their turn by a succeeding apnoea.

The circulatory system of sheep responds to intravenous injections of the extracts of *Zygadenus gramineus* in one of several ways. In the majority of instances there is a rise of blood-pressure accompanied by an acceleration of the cardiac rate. Some of the responses showed little if any change, and still others showed a fall in blood-pressure. In two instances in which a depression of blood-pressure occurred there was very little change in heart rate, indicating a vasodilation. This condition was frequently seen in similar experiments performed upon dogs and rabbits. The latter asphyxial rises of blood-pressure are undoubtedly of a secondary nature.

Believing that the chief toxic action of *Zygadenus gramineus* for sheep was in its great power for depressing the respiration, thus causing asphyxia, the writer, after an hour had been allowed for the animal to recover from the effects of an intravenous injection of the extract, closed the tracheal cannula and produced a graph very similar to one of the asphyxial rises of blood-pressure described above. When extracts of *Zygadenus gramineus* have been injected intraperitoneally or given by means of the stomach tube to rabbits, evidence of asphyxia, such as gasping and convulsive struggles associated with oxygen want, have been observed.

In his experiments with the alkaloidal substances isolated from Zygadenus Reid Hunt[3] found that caffein or diuretin given to rabbits and sheep in conjunction with large amounts of the alkaloidal materials caused such a rapid excretion of these toxic substances that no symptoms of poisoning resulted. The writer has observed that, after intramuscular injection of one grain of caffein dissolved in physiological salt solution with the aid of sodium benzoate, five times as much of the extract of Zygadenus was required to elicit the same response to this extract from a rabbit as was needed before the injection of the caffein. A sheep, following an intravenous injection of an extract of Zygadenus, exhibited a respiratory rate and amplitude of 53.6 and 1.9, respectively. A recovery to 42.1 and 11.6 mm, respectively, was recorded three minutes after the injection of one grain of caffein sodio-benzoate. These results and others of a similar nature furnish supplemental evidence to the findings of Hunt relative to the value of caffein as an antidote for animals poisoned by this plant.

SUMMARY

An extract of *Zygadenus gramineus*, "death camas," from which most of the resins had been removed was given intravenously to sheep prepared for recording blood-pressure and respiratory movements.

Following the intravenous injection of this extract there occurred a respiratory inhibition which in the case of the injection of larger amounts of the extract was followed by asphyxia-like rises of blood-pressure.

The graphic record of this asphyxial condition was practically duplicated by closing the tracheal cannula for a short time following the recovery of the animal from the effects of the plant extract.

Although, from a field standpoint, no satisfactory antidote has been found, it has been demonstrated that caffein sodio-benzoate possesses marked powers of stimulation for the respiratory center affected by the depressive substances found in *Zygadenus gramineus*.

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